NEW-WORLD HEALTH SERIES

BOOKS II AND III

# PRIMER OF SANITATION AND PHYSIOLOGY

BEING PRIMER OF SANITATION AND PRIMER OF PHYSIOLOGY IN ONE VOLUME

BY

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1920 REVISION

YONKERS-ON-HUDSON, NEW YORK
WORLD BOOK COMPANY
1923

WORLD BOOK COMPANY

THE HOUSE OF APPLIED KNOWLEDGE

Established 1905 by Caspar W. Hodgson

YONKERS-ON-HUDSON, NEW YORK

2126 PRAIRIE AVENUE, CHICAGO

"Our national health is physically our greatest asset. To prevent any possible deterioration of the American stock should be a national ambition." These words of Theodore Roosevelt express the idea that has actuated authors and publisher of New-World Health Series. The texts explain the means by which young Americans can lay the foundations for sane and vigorous lives. They stand preëminent among Books That Apply the World's Knowledge to the World's Needs. This particular volume, which combines the second and third books of the series, teaches the essentials of sanitation and physiology. The conservation of individual and national health is the purpose of the series



NWHS: RP OF SP–29



PRINTED IN U.S.A.

# PREFACE

"WHAT you would have appear in the life of the people, that you must put into the schools," is the substance of the advice given by a famous educator to his countrymen. The soundness of this advice has never been questioned, and the experience of the writer of this book has brought the conviction that in sanitary matters it can be applied with absolute literalness, — that our country can hope to shake off completely and permanently its burden of preventable disease only when the public schools give adequate instruction in the principles of preventive medicine and in the possibilities of public hygiene. The author has therefore followed with sympathy and very great interest the efforts that are being made to teach sanitation in the public schools, and has felt that the effectiveness of these efforts would be very greatly increased if they were supplemented by an elementary text-book in this field. With this in mind he has tried to write down in a simple manner, and in a form suitable for school use, the more important facts in regard to germ diseases and their prevention. The public side of the question has been given considerable space, because the relation of the government to the health of its citizens is an important and an intimate one, and because we seem destined to come into a realization of civic obligation largely through public sanitation.

In presenting the subject of physiology, the author has attempted to give the pupil a general idea of the plan and working of his body; to make plain to him the possibilities of health; and to point out the paths that lead to the realization of these possibilities.

The author believes that hygiene is best taught by giving a solid basis of structure and function for it. He has little confidence in get-wise-quick methods in any subject, and he has not hesitated to include sufficient physiology, with the anatomy that is needed to make it intelligible, to give an outline knowledge of the human mechanism. At the same

time, the attempt has been made to select for treatment, from the vast field of physiology, topics that have direct and vital hygienic applications, — to teach hygiene through the modern physiology that lies behind it, rather than to teach hygiene by rule-of-thumb methods or to teach physiology for its own sake. It has been thought best at times to go somewhat far afield with the hope of widening the pupil's hygienic horizon; for the world is filled with people who for lack of a few large ideas are unable to use the many small ones that they have accumulated.

With the idea that children ought not to be taught the matter that is in a book of this kind because it may bring into their minds thoughts of sickness, the author is, of course, not in agreement. The real and vivid ideas of disease that are in the minds of children come not from books, but from personal experience on beds of sickness; from first-hand knowledge of the suffering of disease-stricken parents, brothers, and sisters; and from the sudden vanishing of playmates and friends. As long as disease is in the lives of children, it will be in their minds, and the way to put it out of their minds is to banish it from their lives. The author has done his part in writing this book with the hope that it would do something to bring sunshine and happiness into the lives of the children that now are and are yet to be. He believes that modern hygienic knowledge is able to free our people from most of their illnesses, and that this knowledge ought to be given to the people by the schools that have been founded for their instruction.

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# PART I

# PRIMER OF SANITATION

# CHAPTER ONE

## WHY THE STUDY OF DISEASE GERMS IS IMPORTANT

Suppose that in a happy and healthful village a strange plant should suddenly spring up and give off poisonous matter into the air. Suppose that every one who passed by it became ill, and that all the people who lived near it died because of the deadly gases from the plant. Would the people of the village allow that plant to ripen its seeds and scatter them abroad so that in a short time plants of the same kind would be growing along all the streets and in all the dooryards? Or would the people cut down the plant and destroy it root and branch?

Suppose that poisonous serpents should appear in a town and should attack the people. Would the inhabitants of that town allow the serpents to live and multiply in the streets and about their houses? Or would they hunt out and kill the reptiles that were doing them so much injury?

The people would certainly destroy both the deadly plant and the poisonous serpents, for no one would wish to suffer illness or death because of them.

Poisonous plants like the one described above do not exist, and, in most parts of the world, dangerous serpents are very rare. But in all the earth there is not a town or a village where there are not great numbers of very small plants and animals that attack the people and cause many of them to become sick and die. These small plants and animals are called *disease germs*, and they cause many of the worst diseases that afflict mankind.

In a country where dangerous wild animals are found, the inhabitants know when they are safe and when they must be on their guard; they know that their enemies lurk only in certain places, and by avoiding these places they are usually able to live in security and peace. But a stranger in such a land often imagines that monsters are everywhere waiting for him; even when he is far from danger he is beset with constant fears; and in spite of all his care he is likely to walk straight into the midst of his foes.

So a person who understands about disease germs gives little thought to them, because he knows when he is safe and how and when to guard himself from them. But persons who do not understand about germs often foolishly imagine that the world is full of them; they live in constant fear and make many useless efforts to guard themselves from them; and then in some simple manner they allow the germs to get to them.

In this book we shall study about disease germs and how to avoid them. It is important for you to understand this subject; for a knowledge of it will often enable you to protect yourself from germs; it will allow your mind to be at peace when there is no danger from them; and it will help you to do your part in hastening the time when there will be no more disease germs in our land.

#### POINTS TO BE REMEMBERED

1. Everywhere very small plants and animals called disease germs are attacking people and causing sickness.
2. It is important for you to understand about disease germs in order to know how to escape them and avoid being frightened when there is no danger from them.

# CHAPTER TWO

## THE CELLS OF THE BODY

As a house is built of bricks and a heap of sand is composed of a multitude of small grains, so is the human body made up of a great number of very small parts called *cells*. These cells are so small that we cannot

FIG. 1. When we look at a house from a distance we cannot see the bricks in the walls.

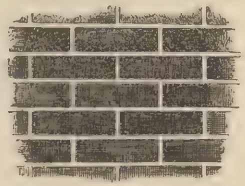


FIG. 2. But when we stand close to the house, we can easily see the bricks of which it is built.

see them without a microscope, but if you could examine a small piece of skin or other part of the body under a microscope, you could very easily see the cells of which it is composed. The skin, the muscles, the liver, the stomach, the brain, and all the other body parts are built of these little cells.[1]

**The cells are alive.** Each one of the little cells of the body is alive. Each one takes in food and grows, and does all those things that make a living being different from sticks and stones and other things that are not

[1] The cells of the body are exceedingly small. So small are they that it would take about 2500 of them placed side by side to make a row an inch long. There are 5,000,000 cells in a very small drop of blood, and according to one estimate, 400,000,000,000 cells in the average human body.

alive. When the cells are in health, the body is in health; and when the cells are dead, the body is dead; for the life of the body is in the cells of which it is built.

FIG. 3. When we look at the body, we cannot see the cells of which it is made. But with a microscope the cells of the body are easily seen.

**Keeping our bodies in health.** Certain things are necessary to the cells of the body. They must have food, they must have oxygen from the air, they must get rid of their poisonous wastes, and they must have a constant temperature, neither too hot nor too cold. If our cells do not have all these things, they will die. They may be killed in other ways, too, as by being crushed, by electricity, and by poisons. To keep our bodies in health, therefore, we must supply our cells with the things that they need and we must keep poisons and other injurious substances away from them.

**Disease germs.** Our bodies are very wonderful machines, but sooner or later sickness comes to most of us. Sometimes the stomach and other digestive organs fail to work properly, and then the cells suffer from a

lack of food. Sometimes the heart and blood vessels become diseased, and then the blood fails to circulate through the body as it should. Sometimes the kidneys fail in their work, and then the cells are injured by poisonous wastes. But the most common of all causes

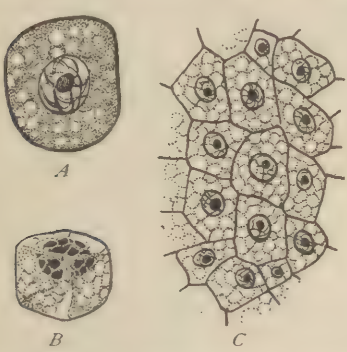



FIG. 4. *A* is a single cell as it appears under the microscope. *B* is a cell drawn to show that it has length, breadth, and thickness. *C* is a group of cells, showing how they are built together in the body.

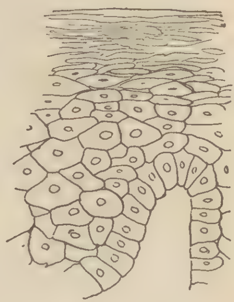


FIG. 5. A section of the outer layer of the skin, as it appears under a microscope. The outer cells die and fall off as dry scales.

of sickness is that disease germs get into the body and poison the cells. In the next chapter we shall learn more about these small germs and how they cause disease.

### POINTS TO BE REMEMBERED

1. The human body is built of very small cells.
2. The cells are alive.
3. When the cells are in health, the body is in health, and when all the cells are dead, the body is dead.
4. The cells must have food and oxygen, and they must not be poisoned or injured in other ways, or they will die.
5. Disease germs cause sickness by poisoning the cells.

# CHAPTER THREE

## DISEASE GERMS AND HOW THEY GET INTO THE BODY

Disease germs are the greatest enemies of mankind. Every day they kill thousands of people, and they cause the loss of an untold amount of time and money. To get an idea of the amount of sickness, sorrow, and loss that is caused by these small creatures, imagine a land where no colds, catarrh, consumption, influenza (grip), diphtheria, or pneumonia ever come; a land where boils, blood poisoning, and tetanus (lockjaw) are unknown; where there is no smallpox, measles, scarlet fever, whooping cough, or mumps; a land without malaria, cholera, leprosy, yellow fever, or plague; a land free from typhoid fever, and from many of the other diseases that afflict mankind. Picture to yourself a country and a people free from all these diseases, a country where many of the inhabitants pass from childhood to old age without sickness or disease, and you will have an idea of what a land without disease germs would be like.[1]

**What disease germs are.** In water and in the soil there are millions of little plants and animals — plants and animals so small that they can be seen only with a powerful microscope. The body of one of these little plants or animals is composed of a single cell. The little one-celled plants are called *bacteria* (singular, *bacterium*). The little one-celled animals are called *protozoa* (singular, *protozoön*). *Disease germs are bacteria and protozoa that grow in the body and poison the cells.*

[1] It is within the power of man to cause all parasitic diseases to disappear from the world. — Pasteur.

**Where disease germs come from.** At this point you should get it firmly fixed in your mind that disease germs are living plants and animals; and that just as a pine tree can come only from the seed of a pine

FIG. 6. The great outdoor world is practically free from germs.

tree, or as a chicken can come only from the egg of a chicken, so a disease germ can come only from another germ of the same kind. It is a common idea that germs spring from unclean and decaying matter —

that "filth breeds disease germs" — but this idea is not correct. They are often found in unclean matter, and such matter is dangerous because germs may remain alive in it for a long time. But germs can no more originate in such matter than a cow can come from the grass in the pasture, or a stalk of corn can spring up where no grain of corn has been planted in the earth. *Nearly all the germs that attack us are spread from the bodies of persons who are sick with germ diseases.*

**The world not swarming with disease germs.** From the very beginning of your study of this subject you should clearly understand that the world is not filled with disease germs that are lying in wait to attack us. It is true that bacteria and protozoa are abundant in water, that bacteria are swarming in the soil, and that they are constantly being blown about in the air. But of all the many hundreds of kinds of bacteria and protozoa that are in the world, only a few cause disease. The others are harmless, and even when they get into our bodies, it is not we, but the bacteria and protozoa, that suffer. The germs of most diseases quickly die outside the human body. It is a mistake to think that every breath of air is dangerous, and that all food and water contain disease germs. The winds that blow over the meadows, the rain that falls from the clouds, the trees of the forest, the grass in the pasture, and, in general, the great outdoor world, are practically free from germs. In the bodies of persons who are sick from germ diseases, in the houses where sick people live, and wherever the wastes from the bodies of the sick go, there, and

in most cases there only, are disease germs to be found.

**The first great rule for the prevention of germ diseases.** The first great rule for the prevention of germ diseases is: *destroy the germs that come from the bodies of the sick.* If all the diphtheria germs that come from human throats could be destroyed, there would soon be no more diphtheria. If all smallpox germs that come from the bodies of persons who have the disease could be destroyed, there would soon be no more smallpox. It is easier to destroy germs as they come from the bodies of the sick than it is to destroy them after they have been spread abroad, and a little intelligent care used in keeping germs from being scattered would every year save millions of lives.

FIG. 7. The germs that attack us come from the bodies of the sick.

**How germs enter the body.** Except in a few cases which we shall discuss later, germs do not pass through the unbroken skin, but *nearly all germs that enter the body get into it through wounds, or through the mouth or nose.* In later chapters we shall learn what germs get into the body through cuts and sores; we shall study about biting insects (mosquitoes, flies, ticks, fleas, and bedbugs) that pierce our germ-proof armor (the skin) and place germs directly in the wounds that they make. We shall read of other germs that enter the body by

way of the nose, and we shall learn how very dangerous germs may reach the mouth from flies, from the hands, from drinking cups, in food and water, and in many other ways. Here we wish only to call your attention to the fact that wounds (many of them made by insects), the nose, and the mouth are the gateways through which disease germs get into the body.

**The second great rule for the prevention of germ diseases.** The second rule for the prevention of germ diseases is: *take care of wounds, protect yourself from biting insects, and guard the mouth and nose.* The first rule aims to keep disease germs from being scattered abroad. The second rule aims to keep out of the body the germs that do get scattered abroad. If we neglect either of these laws, we cannot hope to escape the diseases that are caused by germs.

### POINTS TO BE REMEMBERED

1. Disease germs kill more than half the human race.
2. Disease germs are very small plants and animals.
3. A disease germ can spring only from another germ of the same kind.
4. Nearly all the germs that attack us come from the bodies of sick persons.
5. The first great ruie for the prevention of germ diseases is: *destroy the germs that come from the bodies of the sick.*
6. Germs enter the body through wounds, through the nose, and through the mouth.
7. The second great rule for the prevention of germ diseases is: *take care of wounds, protect yourself from biting insects, and guard the mouth and nose.*

# CHAPTER FOUR

## THE STRUGGLE BETWEEN THE BODY AND THE GERMS

In spite of the greatest care that we can take, all of us are certain at times to get disease germs into our bodies. Between these germs and the body there is then war. The germs attack the body. They try to grow in it and use it for food. To defend itself the body kills the germs. In this chapter we shall learn how the body resists its small foes.

**How germs cause sickness.** The germs of some diseases (diphtheria, tetanus) produce poisons that are called *toxins.* These toxins are carried through the body in the blood, and cause sickness by poisoning the cells. A little group of tetanus germs in a small wound, or a small patch of diphtheria germs growing in the throat, may produce enough toxin to poison and kill the whole body.

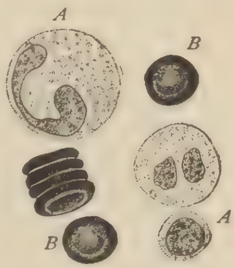


FIG. 8. *A* shows the white and *B* the red corpuscles of the blood as they appear under a microscope.

The germs of other diseases (typhoid fever, pneumonia) produce no free toxins ; but when the germs are killed and broken up, toxins that have been produced within them are set free, and the materials of which the germs themselves are made act as poisons to the cells. In these diseases the end of the illness comes when the germs have all been killed, but the faster they are destroyed the more severe for the time will the disease be.

**How the body destroys toxins.** One way in which the body protects itself against germs is by producing *antitoxins.* When disease germs grow in the body and

begin to poison it with toxin, the body begins to produce antitoxin. *The antitoxin does not kill the germs, but it does destroy the toxin*, and thus saves the cells from being poisoned until in other ways the body can kill out the germs.[1]

**How the body kills germs.** If you should examine a drop of blood with a microscope, you would find a very great number of cells floating in the liquid part of the

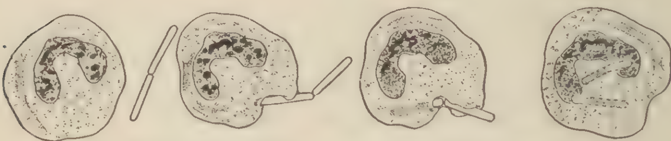


FIG. 9. A white corpuscle taking in a bacterium.

blood (Fig. 8). These cells are of two kinds. Most of them are red in color, and these are called *red corpuscles*. Their work is to carry oxygen through the body. The other kind of cells in the blood are the *white corpuscles*. These are the soldiers of the body, and *their work is to kill disease germs*.

A white corpuscle approaches a germ and flows about it, or swallows it, as you see in Figure 9. Then the corpuscle tries to digest and kill the germ, while the germ tries to grow in the corpuscle and use it for food. When the corpuscles are victorious, the germs are destroyed and the disease is stopped. But if the germs are too numerous and too powerful, the corpuscles are killed, and the disease goes on until the body dies.

[1] There is a different toxin and antitoxin in each different germ disease. The toxin and antitoxin of diphtheria, for example, are different from the toxin and antitoxin of tetanus or of typhoid fever.

Besides the white corpuscles, there is another great defender of the body, the *germicidal* ("germ-killing") substance of the blood. There is always some of this substance in the blood of a healthy person, and when disease germs attack the body, more of the germicidal substance appears in the blood and helps to kill them. In our fight against the germs this germicidal substance is perhaps even more important than the white corpuscles.[1]

**Why we have certain diseases only once.** When germs attack us, the body manufactures more of its germicidal substances to kill them. More and more of the germicidal substance is formed, and the blood becomes stronger and stronger in its power to kill germs. Finally, if the body is successful in its struggle with its enemies, the germicidal substance and the white corpuscles get the upper hand of the germs and recovery begins. After a patient recovers from some diseases (for example, smallpox, measles, and whooping cough), a large amount of germicidal substance remains in the blood for years, or even for life. Any germs of these diseases that get into the blood are therefore promptly killed, and a person is seldom attacked by one of these diseases more than once. Cases of infantile paralysis, pneumonia, smallpox, and many other infectious diseases are treated with blood from a person who has recovered from the disease. Why could such blood be expected to kill the germs?

[1] The body produces different germicidal substances in killing the germs of different diseases, just as different toxins and antitoxins are produced in different diseases. A person therefore may have a great power of killing the germs of one disease, as, for example, smallpox, and at the same time fall an easy victim to some other disease, as consumption.

**Keeping up the resistance of the body to germs.** Through all your study of germ diseases you should bear in mind the importance of keeping up the germicidal power of the body. All of us, without knowing it,

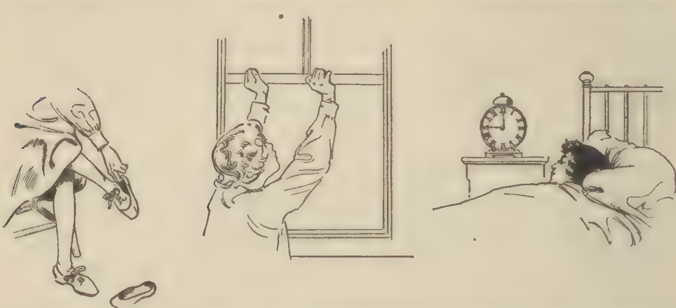


FIG. 10. Dry feet, fresh air, and plenty of sleep help to keep up the power of the body to kill germs.

take into our bodies the germs of deadly diseases. As the seeds of plants lie in the cold earth waiting for the warmth of spring to come, so these germs often lie in the body waiting for a chance to grow. The only safe way, therefore, is to keep the body always in health, so that it will be able to kill any disease germs that may enter it. Overwork, exposure to cold, wet feet, hunger, fatigue, worry, lack of fresh air, lack of sleep, alcohol — all of these things injure the body and lower its germicidal power. It is the duty of every one to keep himself in health — to care for his body intelligently and carefully — and to fail to do this is no more sensible than it would be sensible for the soldiers in a fort to open the gates and lie down to sleep in the midst of their enemies.

**Alcohol and resistance to germs.** Experiments on animals prove that alcohol lessens the power of the body

to kill germs. When alcohol is given to rabbits it is not possible to save them from rabies (hydrophobia) by the Pasteur treatment (page 129). Other experiments show that the germs which cause boils and blood poisoning are able to attack rabbits that have had alcohol more easily than they can attack rabbits that have had no alcohol. Still other experiments show that animals which have been given alcohol cannot resist the germs of cholera, tetanus (lockjaw), and other diseases so well as animals which have not been given alcohol. Experiments like these leave no room to doubt that alcohol taken into the body lessens the power of the blood to kill germs.

Many physicians have long believed that this was true, for they have known that drinkers suffer far more from many germ diseases than do those who use no alcohol. A spell of drinking often brings on an attack of pneumonia, and the death rate from pneumonia is very high among drinkers. Consumption is also very common among drinkers, the records of one foreign life insurance company showing a consumption death rate more than five times as high among brewers as among Protestant ministers. Wounds heal less rapidly in users of alcohol than in abstainers, and the inflammation is more likely to run on into blood poisoning in a drinker. So in cholera and typhoid fever it is the drinkers who suffer most, and there is every reason to believe that this is the case in all germ diseases. Drink no alcohol if you wish to keep up the power of your body to resist germs, for users of alcohol are attacked by germ diseases more frequently than abstainers, and many of them die of these diseases when they are attacked.

**The third great rule for the prevention of germ diseases.** The third great rule for the prevention of germ diseases is: *keep the body in health, so that it will be able to kill disease germs.* A general does not risk the fate of his army on a single battle line, but behind the first line of soldiers he places a second line, and behind the second line he has still a third line of defense in case the enemy

FIG. 11. The Castle of Health. Read the three rules for the prevention of germ diseases, and tell what the two outer defenses of the castle, and the walls of the castle itself, represent.

should break through the first and second lines. So in our warfare with the germs we should not depend on any single line of defense. We should try to keep germs from being spread about, we should guard the gateways by which they enter the body, and within the body we should have the defenders at their posts. For sooner or later, just when we cannot tell, our unsleeping enemies will pass through the first and second lines of our defense, and if at that time the health of the body is low and the defenders of the body are weak, it will be the worse for us.

**Increasing the defenses of the body by vaccination.** Vaccination has been employed as a protection against

smallpox for more than a century (page 119) and of recent years it has been used to increase the resistance of the body to the germs of rabies, boils, typhoid fever, plague, and of many other diseases. In vaccination, weak or dead germs of the kind that cause the disease are introduced into the body. This causes the body to manufacture germicidal substances, or it increases the activity of the white corpuscles, thus providing a defense against the living germs that cause the disease. In later chapters we shall discuss this subject in more detail.

### POINTS TO BE REMEMBERED

1. Dangerous germs often get into the body in spite of the greatest care that we can take.
2. These germs cause disease by growing in the body and poisoning the cells.
3. The body defends itself by producing antitoxins that destroy the toxins.
4. The body kills germs by means of the white corpuscles and the germicidal substances of the blood.
5. We have certain diseases only once because after recovery from these diseases the germicidal substances remain strong in the blood.
6. The germicidal power of the body should not be allowed to run low, because disease germs may be in the body waiting for a chance to grow, or may get into it at times unknown to us.
7. Alcohol lessens the power of the body to kill germs.
8. The third great rule for the prevention of germ diseases is: *keep the body in health, so that it will be able to kill disease germs.*
9. The resistance of the body to certain germs may be increased by vaccination.

# CHAPTER FIVE

## BACTERIA

Bacteria are the smallest of all living things. Millions of them have plenty of room to swim in a drop of water. Twenty-five thousand of them placed side by side would make a row only an inch long. Examined under a microscope that would cause a man to appear as high as Mt. Washington or Mt. Mitchell, these small plants look about as large as periods and commas in ordinary print. So exceedingly small are they that they can pass through the pores of a brick as easily as a man can pass through the doorway of a house.

**The multiplication of bacteria.** Bacteria multiply by simply pinching in two. Some of them can divide and

FIG. 12. A diagram showing the way a bacterium multiplies by pinching in two.

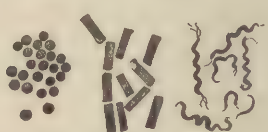


FIG. 13. The three shapes of bacteria, — cocci, bacilli, and spirilla.

become full-grown in fifteen or twenty minutes; but this, of course, is very rapid, even for a bacterium. They can easily divide once an hour, however, and at this rate one bacterium even in a single day can increase to a multitude. It is this power of rapid multiplication that makes disease germs dangerous to mankind.

**The shapes of bacteria.** Bacteria are cylindrical, spherical, or spiral — shaped like a fire-cracker, a marble, or a corkscrew. The cylindrical bacteria are called *bacilli* (singular, *bacillus*). The spherical bacteria are called

*cocci* (singular, *coccus*), and the spiral forms are called *spirilla* (singular, *spirillum*). The shapes of bacteria have nothing to do with the diseases which they cause, but often give a convenient way of distinguishing between different kinds.

**Where bacteria are found in nature.** Bacteria are blown about in the air, clinging to particles of dust. They abound in the upper layers of the soil, but in ordinary soils do not live deeper than six feet below the surface. They are very abundant in the waters of streams, ponds, lakes, springs, and shallow wells, a quart of ordinary well water having in it something like a million of them. They are always found in great numbers about the bodies of men and animals, flourishing especially in the mouth, nose, throat, and intestine, and on the skin.

**Dangerous, harmless, and useful bacteria.** Some kinds of bacteria cause disease, and a few kinds are useful to man. Most of them, however, lead their little lives in the soil, in water, or even in our own bodies, and neither help nor harm us. Among useful bacteria are those that take a part in butter and cheese making, and those that help to increase the fertility of the land. The bacteria of decay, although they destroy much of our food, are also, on the whole, useful to us. Imagine what the world would be like if all the animals and plants that have lived and died in it were lying about us, and you will be convinced that the bacteria of decay are our friends and not our enemies.

**The spores of bacteria.** Certain kinds of bacteria produce *spores* when hard times come upon them. A spore is formed by the living matter of a bacterium

gathering itself into a little, hard ball that rests, like a little seed, until food, moisture, and other good conditions for growth return. Then it grows again into an ordinary bacterium, which goes on growing and multiplying as before. So very difficult are bacterial spores to kill, that some of them have been found alive after they had been dried for ten years, and others are not killed by boiling them for several hours. Fortunately for us, the germs of none of our most common diseases produce spores, and these germs may be killed by a very moderate amount of heat (page 158).

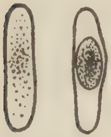


FIG. 14. The right-hand figure shows a spore of a bacterium.

#### POINTS TO BE REMEMBERED

1. Bacteria are the smallest of all living things.
2. They multiply with astonishing rapidity by simply pinching in two.
3. A bacterium is called a bacillus, a coccus, or a spirillum, according to its shape.
4. Some bacteria are useful, and many of them are harmless, but a few kinds produce disease.
5. Some bacteria produce spores that are much harder to kill than are the bacteria themselves.

# CHAPTER SIX

## THE SKIN

Without the skin to protect us, it is probable that bacteria would swarm into our bodies in such numbers that in a week there would not be a living human being in the world. We know that this is true, because most of the bacteria that attack us enter the body by way of two small openings (the mouth and the nose), and because when even a single cut or tear is made in the skin, the body is sometimes hardly able to hold back the germs. If the inhabitants of a besieged city were hard pressed to defend a single open gate of the city, we should not think that they stood much chance of holding back the enemy if the whole city wall were thrown down. So if the body is hardly able to defend itself when there is only one wound in the skin, we should not expect it to keep up the fight long if the covering behind which it is sheltered were removed.


Fig. 15. A section of the skin.

**The structure of the skin**. The skin is composed of an inner layer called the *dermis*, and an outer layer called the *epidermis*. The hairs stand in deep narrow pockets that are called *hair follicles*. Through the epidermis, the

sweat glands open on the surface of the skin by little pores or openings.

**Bacteria that enter the body through the skin.** The weak places in our armor of skin are the hair follicles and sweat glands. Through these weak points certain

FIGS. 16 and 17. If bacteria were large enough for us to see them without a microscope, a pencil that had been in some one's mouth would appear something like this, and the legs of a fly would be seen to be loaded with germs.

bacteria do sometimes work down and cause inflammation, pimples, boils, carbuncles, and erysipelas. These same bacteria also enter the body through wounds, and a considerable number of other disease-producing bacteria get into the body either through wounds or by the bites of insects.

**Bacteria real living plants.** In the next chapter we shall discuss the bacteria that enter the body through the skin. During your study of this chapter, as well as during your study of later chapters, it will help you greatly if you can get a clear picture in your mind of what bacteria are really like. Remember that the moss which clings to the bark of a tree is on the tree, even though you cannot see it from a distance. So if you could only see them with your unaided eyes, there are, as it were, great forests of bacteria growing on your

skin, and clusters of bacteria hanging to particles of dirt and to the legs of flies. Whether we see them or not, bacteria are real living plants, and you should be able to call up pictures of these little plants in your mind.

You can help yourself to get clear and correct ideas in regard to bacteria by asking your teacher about the points that you do not understand, and you can learn much about them from a physician. For physicians know many things about bacteria that are not found in a little book of this kind; they can tell you many things that a teacher cannot be expected to know; and sometimes they allow boys and girls to look at bacteria through their microscopes.

### POINTS TO BE REMEMBERED

1. The work of the skin in protecting us from germs is very important.
2. The skin has two layers, the dermis and the epidermis.
3. The hairs stand in small pockets in the skin that are called hair follicles.
4. The sweat glands lie in the dermis and open on the surface of the skin from below.
5. Certain disease-producing bacteria enter the body through the hair follicles and sweat glands, through wounds, or from the bites of insects.

# CHAPTER SEVEN

## THE PUS-FORMING BACTERIA

THE pus-forming germs are among the most wide-spread of all the germs that are capable of causing disease. They are found in the soil around the dwellings of men and of animals, they are common in unclean water, and they always occur in great numbers on the human skin, where they feed on the dead cells and other matter on the skin. There are several different kinds of these bacteria, but they all cause inflammation and form pus, the thick, creamy, liquid matter that is found in boils and infected wounds.

**Diseases caused by pus-forming bacteria.** The pus-forming bacteria may grow in almost any part of the body and cause inflammation of the part that is attacked. In wounds they cause pus to be formed. In the skin they cause pimples, boils, carbuncles, and erysipelas. Very commonly they attack the walls of the throat or intestine and cause tonsillitis, sore throat, inflammation of the bowels, or appendicitis. Occasionally they attack the membranes around the brain and cause meningitis, or set up their growth in the lungs and cause pneumonia. In like manner they may grow in the lining of the heart, or they may spread through all the body and cause blood poisoning.

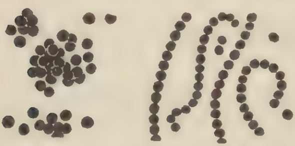


FIG. 18. The two most common pus-forming germs.

**The different kinds of pus-forming bacteria.** The most common of the pus-forming bacteria is a small coccus (*Staphylococcus*[1]) that grows in bunches or clusters

[1] Pronounced stăf-ĭl-ō-kŏk′-kŭs.

(Fig. 18). This coccus is the usual cause of pus in small wounds, of pimples, boils, and carbuncles, and of inflammation and ulcers in the bones. It may also cause blood poisoning, and is sometimes found in other cases of inflammation.

Another common pus-forming bacterium is a coccus (*Streptococcus*[1]) that grows in chains (Fig. 18). This germ causes erysipelas by making a widespreading growth in the skin. It is sometimes found in small sores and boils, but it more commonly attacks the inner parts of the body. It is often the cause of tonsillitis, appendicitis, and blood poisoning. More commonly than any other germ it is found in inflammation of the middle ear,[2] and it causes meningitis and pneumonia more frequently than do the other pus-forming bacteria. It is the most dangerous of all the pus-forming germs.

FIG. 19. A pus-forming bacillus.

A third pus-forming bacterium is a slender bacillus (*Bacillus pyocyaneus*[3]) that sometimes gets into wounds and causes bluish green pus to be formed. It is not so common in the body, nor is it so dangerous, as are the other kinds of pus-forming germs.

**Weak and strong races of pus-forming bacteria.** Some varieties of the pus-forming germs seem to be entirely harmless. Others are exceedingly dangerous, and whenever they have the opportunity produce the most violent

[1] Pronounced strĕp-tō-kŏk′-kŭs.

[2] The running ears that are common among children should receive prompt medical attention, both because there is danger of injury to the hearing, and because there is danger that germs will reach the brain and cause meningitis or a brain abscess.

[3] Pronounced pī-ō-sī-ā′-nē-ŭs.

cases of inflammation and blood poisoning. None of them should be allowed to enter the body when it can be prevented; but germs from a carbuncle, an old abscess, a case of erysipelas, or a case of blood poisoning are far more to be feared than germs of the same race from the skin or from some other source outside the body. It is a common thing for a person with a boil to scratch the germs into the skin with his fingernails, and cause a whole crop of boils in different parts of the body.

**Care of wounds.** For our protection against pus-forming germs it is very important to know how to care for small wounds. If the wound has been made by a clean instrument and bleeds freely, the blood will wash the germs outward, and by its germicidal power will probably kill any bacteria remaining in the wound. In such a case, the best thing to do is to tie up the wound "in the blood," and not open it until it is healed, unless inflammation sets in. A good plan is to wrap the wounded part in a thin, clean, inner cloth, and outside of this tie a second cloth. The outer cloth can be changed from time to time when it becomes soiled, while the inner cloth is left undisturbed to keep germs from getting into the wound. Wounds on the feet and hands, where dust and earth are likely to get into them, should have especially careful attention.

FIG. 20. If a nail or other instrument is driven through the skin, it will carry germs down and leave them among the cells.

A wound that has been made with anything unclean should be carefully washed in pure water, and where particles of earth or other matter have lodged in the wound, it is often advisable to use a clean cloth and pure soap in removing them. Where there is dirt in a wound, the wound should be washed with a disinfectant, as a five per cent solution of iodine in alcohol or ether. It is not best, however, to wash a wound with an irritating disinfectant, for these disinfectants injure the cells in the wound and weaken their resistance to the germs. Turpentine is an excellent agent with which to treat a wound, and a new disinfectant called dichloramine-T is highly recommended.

FIG. 21. A solution of iodine is excellent for treating a wound.

After a wound has been bandaged, it should be carefully watched, and if pain, redness, or swelling shows that germs are growing in it, the wound should be opened and disinfected. A salve, such as borated vaseline, that contains boric acid, is often very useful in treating small infected wounds, and peroxid of hydrogen is used to flush out larger wounds and boils and to kill the germs in them. Peroxid of hydrogen must be used with care, however, or the tissues will be injured by it.

**The pus-forming bacteria injurious to the body.** It is a common belief that boils, pimples, and wounds that refuse to heal are signs of "impure blood," and it is sometimes thought that boils are beneficial to the body. Both these ideas are incorrect. When pus-forming bacteria are able to set up their growth in the body,

it means that the blood is weak in its power to kill these germs, and not that there is any impurity in the blood; and it no more benefits the body to have pus-forming bacteria kill groups of the cells and poison the whole system with their toxins than it would benefit it to be attacked by the germs of typhoid fever, pneumonia, or diphtheria.

**Vaccination against pus-forming bacteria.** Vaccination with dead germs is now a common treatment for boils and for any long-continued infection with either of the more common pus-forming bacteria. A serum prepared from the blood of the horse is also used in severe infections of one of these germs (streptococcus). This serum is similar to diphtheria antitoxin (page 39), but it is prepared by repeatedly vaccinating the horse with dead germs and instead of an antitoxin, it contains a substance for increasing the activity of the white corpuscles.

### POINTS TO BE REMEMBERED

1. The pus-forming bacteria may grow in almost any part of the body.
2. These bacteria cause inflammation, pus formation, pimples, boils, carbuncles, erysipelas, tonsillitis, appendicitis, blood poisoning, and many other diseases.
3. There are weak and strong races of pus-forming bacteria, and the strong races are greatly to be feared.
4. Wounds should be cared for, to keep germs from growing in them.
5. The growth of pus-forming bacteria in the body is a sign that the body is weak and that the health needs attention.
6. The resistance of the body to pus-forming bacteria may be raised by vaccination.

# CHAPTER EIGHT

## TETANUS (LOCKJAW)

Tetanus is not a very common disease, but it is a most severe one. It affects chiefly man and the horse, but other animals may suffer from it. The incubation period (the time from the entrance of the germ into the body to the appearance of the disease) is usually from four to fourteen days.

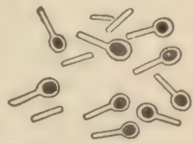


Fig. 22. Germs of tetanus. Most of them have formed spores.

**The germ of tetanus.** The germ of tetanus is a rather long bacillus. It forms spores that are very difficult to kill (page 20). The natural home of the tetanus bacillus is in the soil, but it is swallowed by grass-eating animals, such as the cow, sheep, and horse, and not uncommonly grows in the intestines of these animals (especially in the intestine of the horse) without causing disease. It is therefore very common about stables.

So abundant are tetanus germs in certain kinds of soil that a handful of earth from a barnyard is almost certain to contain them, and the savage tribes of the New Hebrides Islands poison their arrows with tetanus germs by smearing them with earth from crab holes in swamps. A peculiar thing about the tetanus bacillus is that, unless other bacteria are present, *it cannot grow except when shut away from the air.* Along with other germs, however, it sometimes grows in an open wound.

**How the tetanus germ enters the body.** The tetanus germ enters the body through wounds, sometimes through wounds so small that they are not noticed. It is most frequently found in wounds made by unclean

instruments, because such wounds are most likely to get tetanus germs into them, and because dirt and other bacteria are left in wounds of this kind. It grows best of all in small, deep wounds, like those made by an unclean nail, because such wounds readily close over and

FIG. 23. Wounds made by these are often infected with tetanus germs.

leave the tetanus germ, with other germs and dirt, buried deep in the flesh. The percussion caps used on toy pistols, blank cartridges, and firecrackers also make dangerous wounds. The tetanus spores are in dust on the skin, and the small, sharp, flying particles of the cap, the wads of the blank cartridge, or pieces of the firecracker cut deep into the flesh and drive down these spores along with other bacteria and dust.

**The importance of disinfecting wounds.** The bacillus of tetanus is so common that undoubtedly it often gets into wounds in which it never grows. Its home, indeed, is in the earth, and it grows in the human body only when it finds conditions favorable. The disease is so dangerous, however, that it is always wise to look after and protect every wound, especially since the same measures

that cleanse a wound of tetanus germs will also free it from pus-forming bacteria. Wounds made by unclean instruments should therefore be carefully disinfected. Wounds on the feet of barefooted children also should receive careful attention, since these will come in contact with the earth and probably will get tetanus germs into them. It is best to have a physician look after a wound that is especially likely to furnish a favorable place for the growth of tetanus germs; for usually the disease develops suddenly and without any symptoms, often days after the wound is supposed to be healed.[1]

**The toxin of tetanus**. The tetanus germ makes only a very little growth in the body, but it produces a toxin of tremendous power. This toxin for man is a poison twenty times as strong as dried cobra venom, and almost three hundred times as strong as strychnin. It poisons the nervous system and causes all the muscles to be thrown into contraction. One of the first symptoms of tetanus is a stiffness of the muscles of the jaw and neck.

**Tetanus antitoxin**. An antitoxin for tetanus is prepared from the blood of the horse, but it has not proved very valuable in curing the disease, except when used in the early stages and in large doses. It is very valuable, however, in preventing the disease, and when a person has received a wound that is likely to bring on tetanus, a dose of the antitoxin should be given. When this is done, the disease is almost certain to be prevented.[2]

[1] Closing wounds with court plaster shuts out the air and creates conditions favorable for the growth of the tetanus germ.

[2] In 1903 there were in the United States 406 deaths from tetanus following 4449 Fourth-of-July injuries, while in 1907, when antitoxin was more extensively used, there were only 62 deaths from 4413 injuries.

**Other germs that infect wounds.** In addition to the pus-forming bacteria and the tetanus bacillus, there are a number of other germs that often infect wounds in which the tissues are badly crushed and into which dirt or other foreign matter has been carried. One of these, a relative of the tetanus germ and commonly called the gas bacillus, produces a terrible inflammation. Like the tetanus germ, the gas bacillus produces a toxin, for which an antitoxin has been discovered. During the recent war great advances were made in the treatment of wounds of all kinds, and a physician who understands the new methods of preventing infection should be called to attend to any severe wound.

### POINTS TO BE REMEMBERED

1. The tetanus bacillus has its home in the soil and is commonly found about stables.
2. It enters the body through wounds.
3. Usually it grows only in deep wounds and in wounds that dirt gets into.
4. Wounds of a kind that are especially likely to bring on tetanus should be looked after by a physician.
5. The toxin of the tetanus germ is extremely powerful.
6. Tetanus antitoxin is more useful in preventing tetanus than in curing it.
7. It is advisable to give a dose of tetanus antitoxin as a preventive measure when a wound that may cause the disease to develop has been received.
8. Several dangerous bacteria besides the tetanus bacillus live in the soil.
9. The presence of these germs in earth makes it the more necessary to care for wounds.

# CHAPTER NINE

## THE AIR PASSAGES AND THE LUNGS

THE air passages consist of the *nasal chambers* (nose), the *pharynx* (throat), the *larynx* (voice box), and the *trachea* (windpipe) and its branches (*bronchial tubes*). The lungs are composed chiefly of air passages (bronchial tubes), some of which are very fine, and of millions of little air sacs that lie at their ends. The tonsils are two rounded elevations in the side walls of the pharynx. A tube from each of the middle ears opens into the pharynx.

FIG. 24. The solid arrows show the path of the air to the lungs; the dotted arrows show the path of the food to the stomach.

**Communicable diseases of the air passages and lungs.** Among the common germ diseases of the air passages are *colds*, *catarrh*, *influenza*, *tonsillitis*, *bronchitis*, *diphtheria*, and *whooping cough*. The most dangerous diseases of the lungs are *consumption* and *pneumonia*, which in the United States stand at the head of the list of germ diseases as causes of death. The air passages are infected in measles, scarlet fever, and smallpox also; and in mumps, meningitis, and infantile paralysis the germs are in the discharges from the mouth and nose. As will be seen, this is a formidable list of infections, and their control is now the most pressing problem in public health.

**How the germs of respiratory diseases are spread.** The germs of respiratory diseases enter the body and leave the body through the mouth and nose. They reach the hands more easily than the germs of other diseases and pass more readily from one person to another, and in the army cantonments during the great war they were the diseases that were most difficult to control. From our present knowledge it seems probable that the germs are conveyed from one person to another chiefly by the hands; by public drinking cups and the dishes and glasses in public eating places and soda fountains; and by being coughed and sneezed out into the air (page 37). How important each of these methods of infection is we do not yet know. In certain army cantonments and among the workers in a number of public eating places *there was less than one fifth as much influenza where the dishes were washed in boiling water as where they were washed by hand.* One health officer conducted a state-wide campaign based on the two simple ideas of smothering coughs and sneezes and of keeping the hands away from the face, and he believes that by this campaign he reduced the respiratory infections in his state by 30 per cent.

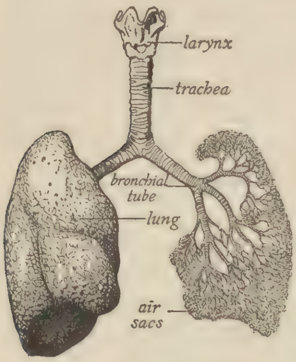


FIG. 25. The lungs.

**Preventing respiratory diseases.** Patients suffering from respiratory diseases must be isolated to prevent the spread of the germs, and coughs and sneezes should

be covered. To avoid these diseases a person should not touch objects that have been touched by others; he should not shake hands unless it is necessary; he should avoid public drinking cups and public eating and drinking places where the dishes are not sterilized; he should keep his hands away from his face and should wash them thoroughly with soap before eating; he should avoid crowds if possible; and he should keep himself in the best possible health so that his resistance to the germs will not be lowered. Experiments prove that fresh air increases the resistance of animals to germs, and all experience indicates that outdoor life, outdoor sleeping, and good ventilation are important in building up the defenses of the body.

FIG. 26. Air sacs that lie at the ends of the small bronchial tubes in the lungs.

**POINTS TO BE REMEMBERED**

1. The air passages and lungs are favorable places for the growth of germs.
2. The germs of respiratory diseases are spread chiefly by the hands, by public glasses and dishes, and by coughing and sneezing.
3. Patients suffering from respiratory diseases should be isolated, coughs and sneezes covered, and the hands kept away from the face.
4. A strong, healthy condition of the body is a great protection against some respiratory diseases.
5. Fresh air strengthens the body against the germs of these diseases.

# CHAPTER TEN

## DIPHTHERIA

SOME cases of diphtheria are so severe that death comes in a day or two. Other cases are so light that they are mistaken for colds in the head or for simple sore throats. The disease is most common in children, and there is always an increase in the number of cases when the children come together in school after the long vacation. The incubation period is usually from two to eight days, but may be less.

**The germ of diphtheria.** The diphtheria germ is a bacillus. It grows most frequently in the throat, but often it is found in the mouth, nose, and larynx.[1] It may grow also on the lips, on the lining of the eyelids, and in other parts of the body.

FIG. 27. The bacillus of diphtheria.

The diphtheria bacillus does not usually grow outside the human body, except when it gets into milk. In most cases it is killed by drying, but when it is protected by matter about it, the bacillus can live for some time. On slate pencils that had touched the lips of children who were in the early stages of diphtheria, the germs were found to be alive after several days, and in dried "membranes" from the throats of diphtheria patients it is known that the germs can live for months.

**How diphtheria germs get into the body.** Diphtheria germs enter the body by way of either the mouth or the nose. They are passed from one person to another

[1] Diphtheria of the larynx is the disease often called membranous croup.

in various ways. They may be coughed out into the air and inhaled,[1] or by spitting they may be spread about in a most dangerous manner. They are almost certain to be on the handkerchiefs of the persons who are carrying these germs, and they can easily get on door-knobs, books, or furniture. They have been found on public drinking cups, and they may be on pencils, chewing gum, pieces of candy, toys, or any of the other objects that are handled and passed around by children. A number of diphtheria epidemics have been caused by milk (page 154), and flies may carry the germs about and leave them where they will reach the mouth and throat. Cats suffer from diphtheria and spread the disease, and other domestic animals probably do the same.

FIG. 28. Diphtheria germs have been found on pencils.

**Difficulties in controlling diphtheria.** In spite of quarantining and the use of antitoxin, there were over

[1] In coughing, sneezing, laughing, and to a certain extent in talking, small droplets of liquid are sent out into the air. They may fly to a distance of several feet (three to nine), and some of them are so very fine that they are said to float in the air for as long as twenty minutes. When a person is suffering from a disease like diphtheria, pneumonia, or consumption, these droplets are, of course, filled with the germs of the disease. One should not stand near a person who is coughing, and a sick person should hold a handkerchief or a paper napkin before his face when he coughs.

17,000 deaths from diphtheria in the United States during 1916. The chief difficulty in stamping it out is that the germs often linger in the throat for four or five weeks, and occasionally for several months, after recovery from an attack of diphtheria. The germ is found also in the throats of a considerable number of healthy persons[1] (often in those who have been in contact with cases of the disease), and in the noses and throats of persons who seem to be suffering only from ordinary colds or from light cases of sore throat. As a fire sometimes bursts forth into flames again after it seems to be dead, so diphtheria, after it seems to have disappeared, often breaks forth anew from these germ carriers. For at any time one of these persons may pass on to others germs that will cause the most severe cases of the disease; or if his resistance to the germs runs low, he himself may be overcome by them.

**Quarantining in cases of diphtheria.** To control diphtheria, every one who is carrying virulent diphtheria germs must be shut up in quarantine, whether he be sick or well. It should be understood that in doubtful cases it is not possible for a physician to tell by looking at the throat whether or not

[1] Investigations indicate that when diphtheria is in a city or town, from three to five healthy persons in every thousand carry virulent diphtheria germs in their throats. In these persons the body is holding the germs in check so that they cannot multiply enough to produce the disease, but it is not able to destroy them entirely.

Many persons (the majority of adults) are immune to diphtheria. It is possible to determine by a simple skin test who these persons are and it is not necessary to give them antitoxin when they have been exposed to the disease. Persons not immune can be made so by the use of a mixture of

it is free from diphtheria bacilli. To determine this, a microscopical examination for the germs must be made.

**Diphtheria toxin.** The diphtheria germ occasionally produces death by causing the throat to close, but the usual cause of death in diphtheria is the very powerful toxin. So poisonous is this toxin that a patch of diphtheria germs the size of the thumbnail growing on the tonsil may produce toxin enough to cause death. The toxin attacks especially the nervous system, the kidneys, and the heart.

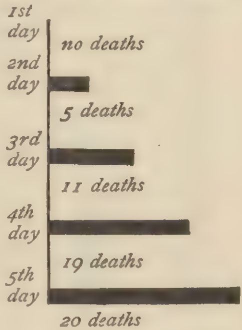



FIG. 29. Showing the number of deaths in 100 cases of diphtheria when antitoxin is used on the first, second, third, fourth, and fifth days. The sooner antitoxin can be used in this disease, the better. The figures are taken from the experience of the London hospitals.

**The antitoxin treatment for diphtheria.** In a former chapter (page 12) we learned that when disease germs produce toxin in the body, the body works up an antitoxin to destroy the toxin and save itself from being poisoned. Working in accordance with this principle, scientists have learned how to get a diphtheria antitoxin from the

toxin and antitoxin, and the inmates in a number of children's homes have been protected in this way. It is probable that this method will be employed to protect nurses and others who are especially exposed to the germs. Like vaccination against smallpox and typhoid fever, it may be generally used to check the spread of the disease.

Chronic carriers of diphtheria germs usually have diseased tonsils, and removal of the tonsils causes such persons to become free from the germs. Infected tonsils seem also to make one more liable to the disease.

blood of the horse.[1] When a person is attacked by diphtheria, some of the antitoxin from the horse is injected into the body. This does not kill the diphtheria germs, but destroys their toxin and saves the cells from poisoning until the body can kill out the germs and so stop the disease.


FIG. 30. When no antitoxin is used in the treatment of diphtheria, about forty-four patients in a hundred die. When antitoxin is used, there are only one fourth as many deaths (eleven in a hundred).

It is very important that the antitoxin be given in the early stages of diphtheria, for after the toxin has poisoned the cells of the nervous system, kidneys, and heart, great damage has been done, and it is not possible to undo it. Antitoxin is useful in all stages of the disease, however, and should always be used. It is also very useful in preventing diphtheria, and when a person has been exposed to the germs, a dose of antitoxin is often given to prevent the development of the disease.

**The results of the antitoxin treatment.** From the very beginning of its use in the treatment of diphtheria,

[1] The antitoxin is prepared in the following manner: Diphtheria germs are placed in beef broth, where they multiply and produce great amounts of toxin. A little of this toxin is then injected into the blood of a horse, and the horse begins to work up antitoxin to destroy it. A larger dose of toxin is then given to the horse, and still more antitoxin appears in the blood. More and more of the toxin is injected, until the blood of the horse is made as strong in antitoxin as possible. Then the horse is bled and the blood allowed to clot. The thin yellow liquid (serum) that appears around the clot contains the antitoxin. After being freed from certain impurities, this serum is sealed up in glass containers and sold as antitoxin.

antitoxin has been a great success. Indeed, when antitoxin is given in the very early stages of the disease, there are almost no deaths; and in some states when a death from diphtheria is reported an investigation is made to determine who was responsible for the failure to use the antitoxin in time. It should be understood that the paralysis which sometimes follows diphtheria is not caused by antitoxin, but by the disease. After an attack of diphtheria the heart is weak, and violent exercise should not be taken.

## POINTS TO BE REMEMBERED

1. The diphtheria germ usually grows only in the body, but it may live for some time outside the body.
2. It is transferred from one person to another in many different ways.
3. It is often found in the throat long after the patient has recovered, and is occasionally found in the throats of healthy persons.
4. Every one who is carrying virulent diphtheria germs should be quarantined, whether he is sick or well.
5. The diphtheria germ produces a very powerful toxin that poisons especially the cells of the nervous system, the kidneys, and the heart.
6. By injecting diphtheria toxin into a horse, the blood of the horse can be made very strong in antitoxin.
7. If this antitoxin is used when a person is attacked by diphtheria, it saves the body from being poisoned.

# CHAPTER ELEVEN

## PNEUMONIA

Up to about ten years ago consumption caused more deaths in all parts of our country than any other germ disease. Now a better understanding of how to avoid the germ of consumption, and a better knowledge of how to treat the disease, have considerably lessened the death rate from consumption; and in some of our northern states the pneumonia germ now claims more victims than any other of our microbe enemies. Each year it causes about 125,000 deaths in the United States. Pneumonia is much more common in cities than it is in the country, probably because in a city, where the people are crowded together, the germ is more easily passed from one person to another, and because fresh air is less abundant in the city than it is in the country.

**The character of the disease.** Pneumonia usually begins with a chill (often a very severe one), cough, fever, pain in the side, and rapid breathing. The sputum has a rusty color caused by blood from the air sacs of the lungs. The disease runs a swift and severe course, the crisis coming usually in from three to eight days. In rare cases death is caused by the closing of the air sacs in so great a portion of the lungs that the patient cannot breathe, but more commonly the heart is overwhelmed by the toxin that is carried from the diseased lungs by the blood. Pneumonia attacks particularly children under five years of age, aged persons, and those who for any reason are weak or sick. Users of alcohol are especially liable to pneumonia, and all physicians know that drinkers fare badly when attacked by this disease.

**The germ of pneumonia.** Pneumonia may be caused by a number of different germs, but in most cases a small coccus[1] is the invader. This germ grows not only in the lungs but also in the nose, mouth, throat, and air passages; in children it is a very common cause of inflammation in the middle ear, and it is sometimes the cause of meningitis. The pneumonia germ attacks many animals, and it is possible for man to get the disease from animals.

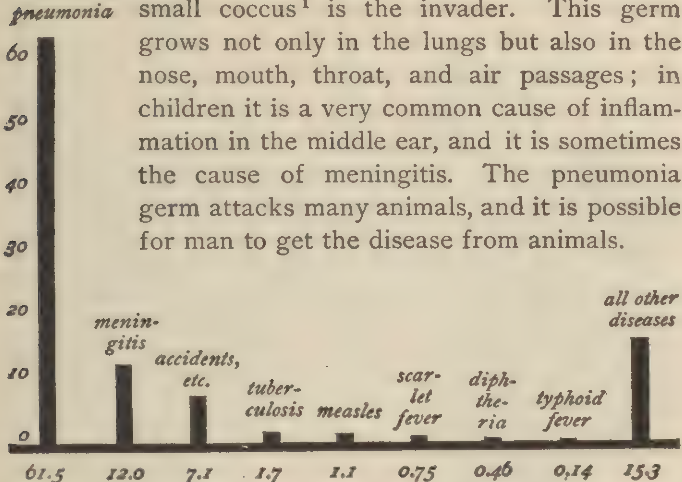



FIG. 31. Diagram showing death rate in U. S. Army for six months (Sept. 29, 1917, to March 29, 1918) from pneumonia as compared with other diseases.

**How pneumonia germs enter the body.** Pneumonia, like diphtheria, is an infectious disease. The germs are in the sputum and often in the discharges from the nose of a pneumonia patient; they are passed from one person to another in all the ways that diphtheria germs are spread abroad (page 37); and they enter the body through the mouth or nose. The germs are killed by drying, and outside of the body they quickly die.

**Preventing the spread of the germs.** Pneumonia, like diphtheria, is a communicable disease. No one should go about a pneumonia patient except those who are

[1] *Pneumococcus* (neu-mo-kŏk′-kus). In the army cantonments during the great war, the streptococcus was also a common cause of pneumonia.

waiting on him, and the sputum of the patient should be destroyed.[1] The avoidance of crowding is also important in preventing pneumonia. Among the laborers on the Panama Canal it was the most troublesome disease; and in the army cantonments, during the recent war, it led all infections as a cause of death. It is believed that a method of vaccinating that gives protection against the disease has been found.

FIG. 32. Kiss the baby on the cheek, not on the mouth. If it isn't your own baby, do not kiss it at all.

**Preventing pneumonia by keeping up the health.** The pneumonia germ is one of the most widespread of disease germs, and it is not always possible, try as we may, to avoid it. During pneumonia epidemics, therefore, it is advisable to make a special effort to keep up the general health so that the body may be able to kill any pneumonia germs that may reach the lungs. To keep up the health a person should avoid all exposure to wet and should wear sufficient clothing to protect himself from cold. He should avoid alcoholic drinks, for the man whose power to resist germs is

[1] A physician reports the following as occurring in a rural community: An elderly woman suffered a severe attack of pneumonia. Two women from neighboring families who helped care for her contracted the disease. The husbands of these women were next stricken, and two other persons also were attacked. Two of the seven cases ended in death.

lessened by drink falls into the hands of a terrible foe when the pneumonia germ attacks him. A person should also eat good food, take plenty of sleep and exercise, and should spend as much time as possible in the open

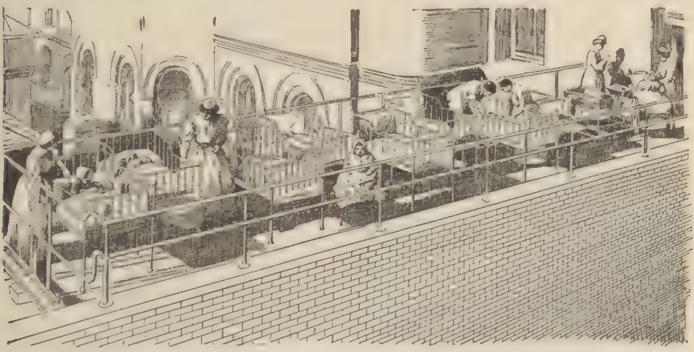


FIG. 33. Pneumonia patients being treated in the open air. (*After photograph of patients in the Presbyterian Hospital, New York.*)

air. Anything that builds up the general health is a safeguard against pneumonia, and anything that weakens the body may bring on pneumonia. In some of the army camps it was noticed that respiratory diseases increased when the ground thawed and the men's feet became wet.

**The importance of fresh air**. There is little doubt that the resistance of the body to pneumonia germs is often weakened by a lack of fresh air. By many it is believed that the large number of pneumonia cases in February and March is to be accounted for on the theory that we have been weakened by living indoors all winter, often in houses that are not sufficiently ventilated. Physicians and boards of health are more and more recommending fresh air as a means of keeping up

the health, and in treating pneumonia some of the most successful physicians carry the patients outdoors even in the coldest weather, as is done in the treatment of consumption. Any one who wishes to keep up his resistance to the pneumonia germ cannot afford to neglect the fresh air factor.

**POINTS TO BE REMEMBERED**

1. Pneumonia causes more deaths in our country than any other germ disease except consumption.
2. It runs a swift course, and death is usually due to toxins that are carried out of the lungs in the blood.
3. Pneumonia may be caused by several different germs, but it is nearly always due to a small coccus (the pneumococcus).
4. This germ may grow in other parts of the body besides the lungs, and attacks animals as well as men.
5. The pneumonia germ spreads by contact infection and enters the body through the mouth and nose.
6. The sputum of pneumonia patients should be destroyed, and pneumonia should be treated as an infectious disease.
7. The avoidance of crowding is important in the prevention of pneumonia.
8. It is believed that a successful method of vaccinating against pneumonia has been found.
9. The pneumonia germ is widespread, and we should keep up the health and the germicidal power of the body to protect us from this disease.
10. Fresh air is one of the greatest factors in building up the resistance of the body to pneumonia.

# CHAPTER TWELVE

## INFLUENZA, WHOOPING COUGH, AND COLDS

### INFLUENZA

INFLUENZA (grip) was little known in the United States until 1889–1890. Then a great epidemic swept over the country, and the disease has been common with us ever since. It is, however, an ancient disease, and epidemics of it were common in Europe in the Middle Ages. It was also common in other parts of the world before its introduction into the United States. Usually it causes in the United States about 12,000 to 15,000 deaths a year, but in 1918 a great epidemic broke out, and in six months more than a half million of our people died of it.

FIG. 34. A letter carrier during the great influenza epidemic.

**The germ of influenza.** Influenza is probably caused by a filterable virus (page 194). The germs are in the sputum and the discharges from the nose, and it is probable that the disease is communicable only in the early stages. The incubation period is very short, and it is the most catching disease known.

**Influenza a serious disease.** The influenza germ produces a powerful toxin that has a profound effect upon

the whole body. It does not poison the body so acutely as does the toxin of the diphtheria germ, but it causes a depression and weakness that often last for months. Another bad feature of the disease is that other troubles, such as pneumonia, consumption, eye and ear diseases, bronchitis, and colds, often follow it, and it may leave a part of the body, as the stomach, the kidneys, or the nervous system, in a weakened condition. Because it is so widespread, and because its after-effects are so serious, influenza is a much-dreaded disease. The most important point in the treatment of the disease is for the patient to go to bed at once and remain in bed until the danger is over.

**Guarding against influenza**. Influenza is so infectious that only a most careful quarantine of first cases will control it. Masks have proved helpful in some hospitals in protecting nurses and physicians from respiratory diseases, but most health officials seem to think that the public will not wear them in a way to make them of much use in influenza time. To be effective, masks must be made of closely woven material, they must be changed frequently, and they must not be turned wrong side out after being worn. To protect a person from germs coughed out by others a mask should cover the eyes as well as the mouth and nose. Good health is no protection against the disease. In the great 1918 epidemic the well and those in the prime of life were especially attacked.

FIG. 35. In droplets that are coughed out into the air the germs of influenza, colds, and other respiratory diseases are found (see footnote, page 37).

## WHOOPING COUGH

The incubation period of whooping cough is usually from four to fourteen days, but it may be as long as three weeks, and the "whoop" may not show itself for some time after the commencement of the attack. It is especially infectious in the very early stages. A child may be permitted to return to school in five weeks after the beginning of the whoop, provided the severe coughing spells have ceased.

**Whooping cough dangerous to children.** Whooping cough is not usually supposed to be very dangerous, and often cases of it are not carefully quarantined. As a consequence, it is a widespread disease and causes more deaths than scarlet fever and smallpox combined — more than any of the other common infectious diseases of children. Some persons make no effort to protect their children from whooping cough, or even purposely expose them to it. This is the most pernicious practice, for more than four fifths of all deaths from whooping cough are among children under two years of age. The older a child is, the better he resists the disease, and an adult usually either escapes it altogether or has a mild attack.

**Quarantining in cases of whooping cough.** To children under five years of age, whooping cough is a very dangerous disease, and cases of it ought not to be allowed to run unchecked with the idea that every one must have it. During quarantine the patient need not be shut up indoors, but he ought to keep away from others who might become infected with the germs. A vaccine is now prepared that will often prevent the disease. It

will also shorten and lessen the severity of the attack if used promptly when the first symptoms appear. Dogs and cats suffer from whooping cough, and during epidemics they may be a means of spreading the germs.

## COLDS

Colds are caused by germs that are transferred from one person to another. In no other way can the fact that they run in epidemics be explained.[1] They are the most common of all the germ diseases of temperate climates, and the most difficult to avoid. The germs pass easily from one person to another, and it is astonishing how quickly an epidemic can spread through a community.

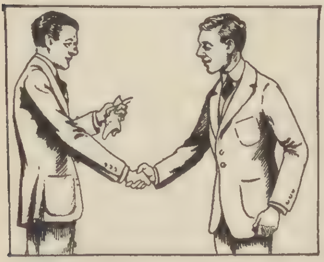


FIG. 36. The germs of colds pass easily from one person to another.

**The cause of colds.** The first cause of an epidemic cold is probable a filterable virus (page 194). In later stages of an acute cold and in chronic colds, bacteria, often several different kinds together, are found growing in great numbers in the air passages. Among the bacteria commonly present are the pneumonia germ, pus-forming bacteria (especially streptococcus), a bacillus that sometimes causes pneumonia,[2] a small coccus

[1] I have long been satisfied from observation that people often catch cold from one another when shut up in close rooms and coaches, and when sitting near and conversing so as to breathe in each other's transpiration. — BENJAMIN FRANKLIN.

[2] *Pneumo-bacillus.*

often found in catarrh, and a small bacillus often present in influenza. In ordinary colds it is probable that the filterable virus first attacks and weakens the linings of air passages and that the bacteria then set up their growth on them.

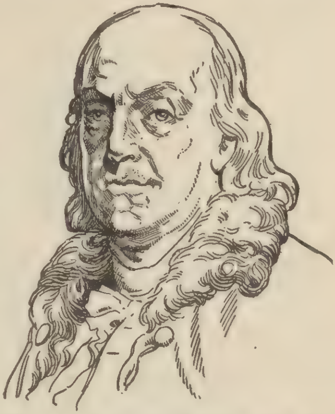


FIG. 37. Benjamin Franklin, who was one of the shrewdest men and one of the best scientists of his day. More than a hundred years ago he observed that people catch colds from each other.

**Catarrh and bronchitis.** Catarrh is a chronic cold, and bronchitis is a cold of the lining of the trachea and bronchial tubes. The small coccus (*Micrococcus catarrhalis*) that is sometimes present in ordinary colds is very frequently found in chronic catarrh, and the pneumonia germ and pus-forming bacteria (streptococci) are common in cases of bronchitis. Chronic catarrh and bronchitis are difficult diseases to cure, and they should not be allowed to fasten themselves on children.

**Avoiding the germs that cause colds.** A person who is trying to avoid the germs of colds should not borrow pencils, books, or other articles from any one who has a cold; he should not touch soiled handkerchiefs, use public drinking cups, or stand near any one who is coughing without turning away from him; he should keep his hands away from his own mouth and nose, and should frequently wash his hands thoroughly with soap and water (page 161). He should also avoid wet

feet, chilling the body, alcoholic drinks, or anything else that will lower his resistance to germs. A person who has a cold should change handkerchiefs frequently, turn

FIG. 38. One way in which the germs of colds and other respiratory diseases may be passed from one person to another.

away from others when he coughs, disinfect his hands occasionally, and in other ways try to prevent the spread of the germs.

### POINTS TO BE REMEMBERED

1. Influenza is a serious disease, and the germs should be avoided as much as possible.
2. A person with influenza should go to bed at once.
3. Whooping cough is a serious disease and should be quarantined.
4. Colds, catarrh, and bronchitis are caused by germs growing in the air passages and throat.
5. These diseases are infectious, and care should be taken to prevent the spread of the germs.
6. Keeping up the resistance of the body is an important safeguard against colds.

# CHAPTER THIRTEEN

## TUBERCULOSIS

PROBABLY from the earliest times, mankind has been afflicted with tuberculosis, for a great Greek physician named Hippocrates wrote a treatise on consumption in 400 B.C., and in the lungs of Egyptian mummies the marks of consumption have been found. At the present time *Bacillus tuberculosis*, or the *tubercle bacillus*, as it is sometimes called, is the most deadly of all the bacterial enemies of man. In our own country, more than one tenth of all deaths are caused by this germ, which means that the "Captain of the Men of Death" is killing our fellow-countrymen at the rate of 150,000 a year, over 400 a day, and one every three and a half minutes. Years ago Oliver Wendell Holmes called consumption the Great White Plague, and it richly deserves the name.

**The cost of tuberculosis.** Because tuberculosis selects its victims especially from those who are in the active working years of their lives,[1] and because it is a lingering illness, it costs us far more in money than does any other disease. It is difficult to calculate the cost of sickness in dollars and cents, but one estimate that has been widely accepted places the cost of tuberculosis to our country at a billion dollars a year. Just now great a sum this is you will realize better when you know that it is more than two sevenths as much as the yearly wages of all the factory workers in the United States, nearly one half more than the whole country spends on its public and high school system, and nearly ten times as much as it spends on its colleges and universities. Yet the

[1] One third of all deaths between the ages of fifteen and forty-five are from tuberculosis.

death rate from tuberculosis has fallen amazingly in the last thirty years, and it would be a simple matter to prevent nearly all cases of the disease.

**The germ of tuberculosis**. The germ of tuberculosis is a slender bacillus. It is a slow-growing bacterium, but it is a very hardy one, and often it resists all attempts of the body to kill it and grows steadily on until it causes death. Outside the bodies of men and animals it does not grow at all in nature, and light and drying kill it. Yet in a dark, damp house the germs in the sputum of a consumptive may live for several months or perhaps for a whole year. Away from the habitations of men and animals the tubercle bacillus is not found, but it is often present in the earth and refuse about places where cattle are kept, and in the rooms of careless consumptives.

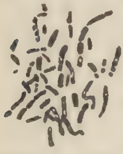


FIG. 39. The bacillus of tuberculosis.

**Different forms of tuberculosis**. The tubercle bacillus may grow in almost any part of the body and cause tuberculosis of the part attacked. Tuberculosis of the lungs, or consumption, is the best-known form of the disease, and causes by far the most deaths. Tuberculosis of the bones is also a common trouble, and most of the lame and crippled people that we see have been deformed by tuberculosis of the spinal column, or of the bones of the hips, legs, or feet. Tuberculosis of the bones is especially common among children, as is also scrofula, or tuberculosis of the lymphatic glands. Tuberculous meningitis, which causes more deaths than any other form of tuberculosis except consumption, is more common among children than among older persons. The skin, kidneys, intestine, larynx, and other parts of the body also may

be attacked by this germ; and when the tubercle bacillus is growing anywhere in the body, it is always possible for it to be carried by the blood to the lungs.

**How the tuberculosis germs enter the body.** It is not possible in most cases of tuberculosis to tell how the germ got into the body. There is no doubt, however,

FIG. 40. Many of the lame and crippled people that we see have been deformed by tuberculosis of the bones.

that some cases come from breathing in germs from dried sputum and from droplets that have been coughed out by consumptives, and that many other cases come from germs that have been swallowed and that have passed through the walls of the intestine into the blood. It is probable that the germ gets into the body by way of the mouth more commonly than was formerly supposed.

**How tuberculosis germs are scattered.** The form of tuberculosis that is most dangerous to those about the patient is consumption. In this disease, the germs may be coughed out into the air in droplets of saliva, they may be carried by flies if all sputum is not carefully de-

stroyed at once, and they may be spread abroad in all the ways that pneumonia and diphtheria germs are scattered (page 37). Dishes that have been used by a consumptive are a source of danger unless they are disinfected, and food that a consumptive has prepared or touched may contain the germs. The tuberculosis germs may also be in milk or water, they may be carried on the feet from sidewalks and other places where people spit, and in almost countless other ways these germs can reach the mouth and nose. They can withstand considerable drying, and in dried sputum they remain alive and virulent after the germs of most other common diseases would be dead. This makes especially dangerous the habit of spitting that some careless consumptives have, for in the advanced stages of the disease several billion germs are thrown off daily from the lungs. Indeed, it is not right for any one to spit in public places, for it is probable that more than one half of the people in our country who have consumption, do not know that they are afflicted with the disease.

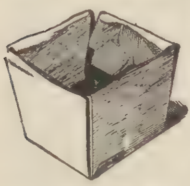


FIG. 41. A waterproof pasteboard sputum cup. These are very cheap and they should be burned after being used.

**Disinfecting sputum.** The importance of destroying the sputum of consumptives cannot be too strongly insisted on. It should be received either in pasteboard cups that can be burned, or in a vessel that contains a disinfectant. Carbolic acid is a good disinfectant to use for this purpose, but lysol is better, for it dissolves the mucus of the sputum and allows the disinfectant to get quickly to the germs (page 160). When the consumptive is traveling, the sputum may be

received in waterproof envelopes or pocket sputum cups that are made for the purpose, or on pieces of cloth that may be carried in a paper bag until a fire is reached. The sputum should not be swallowed, for if this is done, the germs may set up intestinal tuberculosis, or they may pass through the intestinal wall, be carried away in the blood, and start the disease in some part of the body that has not yet become infected. Under no circumstances should the sputum be allowed to dry, for in the dry condition it is impossible to keep the germs from being scattered about.

FIG. 42. A pocket sputum cup, to be burned after being used.

**Other precautions to be taken.** A consumptive should hold a paper napkin or a handkerchief before his face when he coughs, and these napkins or handkerchiefs should be burned, or placed in a disinfectant, or kept in water until they can be boiled. A consumptive should learn to keep his hands away from his face and mouth, and should occasionally wash his hands in a disinfectant. He should have his own dishes, and these should never be washed with other dishes, nor allowed to come in contact with them until after being boiled for at least five minutes. His bedclothes, clothing, and furniture ought occasionally to be disinfected, or at least exposed to the bright sunshine as much as possible, and his clothing should be boiled before it is washed with other clothes. A consumptive should have a sleeping room to himself, and this room should be kept bright and well ventilated, to help kill any germs that may be free in it. A house in

which a consumptive has lived should be disinfected before any one else moves into it.

**Danger from a consumptive.** In Indiana in 1910 the state health officials investigated more than 900 new cases of consumption and found that in more than half of them the patient had been living or working with a consumptive. These and other recent studies indicate that those who live with consumptives run a great risk of becoming infected with the germs (page 200). A consumptive should, therefore, take great care not to endanger those about him. Any one who lives with a consumptive should take the greatest care to guard against infection, and he should be especially careful of his health so that his body will at all times have as much resistance as possible to the germs.

FIG. 43. This house stands at the edge of a small village. Sunshine and pure country air are abundant about it, but the house is infected with tuberculosis germs. In six years three different families lived in it, and each of these families had one or more members stricken with consumption while living in the house.

**Alcoholism and tuberculosis.** In a former chapter (page 15) it was stated that alcohol lessens the power of the body to kill germs and that the death rate from consumption is much higher among brewers than among ministers; also that the person who uses alcohol makes himself more liable to tuberculosis. So closely connected are the use of alcoholic drinks and tuberculosis that in Paris, in 1905, the International Tuberculosis Congress adopted the following resolution: "*We strongly emphasize*

*the necessity and importance of combining the fight against tuberculosis with the struggle against alcoholism."*

## TUBERCULOSIS IN ANIMALS

Tuberculosis is a common disease of chickens and turkeys, but the tubercle bacillus of birds does not seem to be able to attack man. Many domestic animals also suffer from tuberculosis, the disease being especially common among cattle and among hogs that have run in barn lots with tuberculous cattle or have been fed on milk from infected cows. The tubercle bacillus of cattle and of hogs (the "bovine type") of the germ can grow in the human body. It attacks children much more frequently than it does older persons, and it usually grows in the bones, in glands, or in the walls of the intestine, rather than in the lungs.

**Tubercle bacilli in milk**. The tubercle bacillus may at times get into the body from meats, but infection from milk is much more important. Where the disease is allowed to run uncontrolled, from 15 to 30 per cent of dairy cattle have the disease, and from 5 to 9 per cent of the unpasteurized milk sold in certain of our cities has been found to contain living tuberculosis germs.

**Danger from the bovine type of the tubercle bacillus.** The bovine variety of the tubercle bacillus is fitted for growth in the body of the cow rather than in the human body, and it is believed to be much less virulent for man than is the "human type" of the germ that is usually found in the sputum of a consumptive. The question of tuberculosis among cattle is an important one, however; for 10 per cent of all deaths from tuberculosis among children under five years of age are due

to the bovine type of the germ, and many thousands of other persons are being infected by these germs each year. A very simple and certain method of testing cattle for tuberculosis has been discovered, and even if there were no danger of man's getting the disease from milk, tuberculous cattle should be separated from those that are free from the disease. This is economy; for by taking out of a herd all the animals that have tuberculosis, the spread of the disease in the herd can be stopped. Milk from a dairy that is not known to be free from tuberculosis should be Pasteurized before it is used (page 156).

### POINTS TO BE REMEMBERED

1. Tuberculosis costs the United States 150,000 citizens each year, and it is estimated that its annual cost in money is $1,000,000,000.
2. The tubercle bacillus is slow-growing, but it is very difficult to kill.
3. In tuberculosis any part of the body may be attacked, but consumption is by far the worst form of the disease.
4. The germs enter the body either by being inhaled or by being swallowed.
5. They withstand drying and are scattered in many ways.
6. The sputum of consumptives is full of germs, and it should be burned or disinfected.
7. Most cases of consumption are contracted by contact infection, and a careless consumptive is dangerous to those about him.
8. The tubercle bacilli that are often present in milk are dangerous to man.
9. Milk that may contain tubercle bacilli should be Pasteurized.

# CHAPTER FOURTEEN

## THE TREATMENT OF CONSUMPTION

THE steady manner in which consumption often runs on and on has caused many persons to think that it is an incurable disease. This is a great mistake. In very many persons who become infected in early life the germs are walled off and held dormant in the lymphatic glands or other parts of the body, and it is a very common occurrence for the tubercle bacillus to start its growth in the lungs and to be checked by the body without the person who is being attacked ever knowing what is happening. If consumption is taken in hand before the germs have gained a secure foothold, it yields to treatment much more readily than many other bacterial diseases.

**The importance of early treatment.** In the treatment of consumption, everything depends on beginning in the early stages of the disease (Fig. 44). One who has symptoms[1] of consumption, therefore, should not try to persuade himself that his symptoms have no existence, for this will not stop the growth of the germs. He should not lose valuable time experimenting with patent medi-

[1] The most common symptoms of consumption are cough, loss of appetite, gradual loss of weight and strength, fever in the afternoon, night sweats, and blood spitting. The cough may be absent in the very early stages of the disease, or it may be troublesome only in the early morning and after going to bed at night. Any one who loses weight or finds himself becoming tired easily, should have himself examined at once, even though he have no cough. By writing to the Secretary of the State Board of Health at the capital of his state, or to the State Society for the Prevention of Tuberculosis, a consumptive can obtain helpful literature and trustworthy advice. In many cities and counties public dispensaries are maintained to which any one who wishes advice about tuberculosis may go

cines, for there is no medicine known that will cure consumption. The only sensible thing for him to do is to be examined at once by a physician who thoroughly understands the disease. Then, if he finds that the

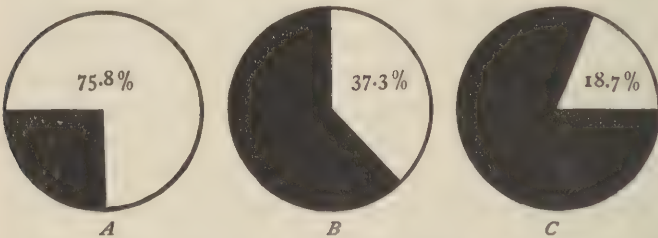



FIG. 44. The amounts of white in *A*, *B*, and *C* show the chances that a consumptive in the early, moderately advanced, and advanced stages of the disease has of being cured or of having his disease arrested. These figures are from the experience of the State Sanatorium at Rutland, Massachusetts. From 1889–1907 this institution treated 1911 persons who were in the early stages of consumption, and in 1450 of them the disease was apparently cured or arrested. Of moderately advanced cases 1616 were treated, and in 604 of them the disease was apparently cured or arrested. Of more advanced cases 784 were treated, and in only 147 was the disease apparently cured or its progress stopped. These figures show the very great importance of early treatment of the disease.

germs have gained a foothold in his lungs, he should give himself the best possible treatment without delay.

**Important factors in treatment.** In the successful treatment of consumption, the following are the more important factors: —

*Rest.* If a consumptive can be kept quiet, much of the toxin that is produced by the germs will be thrown off in the sputum. Anything that causes the breathing to be quickened and deepened causes more of the toxin to be carried from the lungs through the body, and increases the fever.

A consumptive should therefore have rest. If he has

fever, he should have absolute rest, not even walking about his room. Laughing and loud talking should be avoided, and coughing should be refrained from as much as possible. When there is no fever, a little exercise may be taken, but it should be taken with care.

*Food.* A consumptive should have an abundance of nourishing food, especially of fatty food. Meat, eggs, milk, and any other good foods that he can eat and digest should be taken. Lunches should be eaten between meals and on retiring. The foods must be well prepared and served in different ways, or the patient will become tired of them. "Stuffing" a patient, however, may cause indigestion, and the diet of a consumptive should be looked after carefully.

FIG. 45. An outdoor sleeping place, of a kind that most consumptives can have.

*Outdoor life.* Nothing in the treatment of consumption is more important than fresh air, and the disease has been most successfully treated when the patients have lived and slept in the open air, summer and winter. Often an upper porch can be arranged as a sleeping place. In outdoor sleeping in winter, it is necessary to have warm clothing and to wear some kind of hood to protect the head and neck, and in many places in summer it is necessary to screen the patient from mosquitoes.

*Other important points.* Warm and dry clothing is of

course important. Sunlight on the skin increases the number of white corpuscles in the blood and is used in the treatment of tuberculosis, but too much exposure to light is injurious, and the advice of a physician is needed

FIG. 46. Consumptives taking the winter air on a city roof.

in taking the light treatment. A consumptive should not remain in a damp house.

Finally, every consumptive should have a skilled physician to watch over and guide him in his treatment of himself, and he should secure some of the many books and circulars that have been written on consumption and its treatment, and learn how to live in a way that will give the best possible chance for recovery.[1] He should

[1] Hawes's *Consumption: What It Is and What to Do About It* (Small, Maynard & Co., Boston) is an excellent little book for consumptives. Brown's *Rules for Recovery from Pulmonary Tuberculosis* (Lea & Febiger, Phila-

always think of the safety of others and should take care not to endanger those about him. He should be cheerful and hopeful, for if he takes his disease in time he has every reason to expect recovery.

FIG. 47. Window tents can be bought that allow a consumptive to obtain fresh air through an open window while his body remains in bed in a warm room. This tent was designed by Dr. S. A. Knopf.

**The effect of climate on consumption.** It was formerly supposed that climate was very important in the treatment of consumption, but in all our states consumptives are now being cured, and it has been found in treating this disease that rest, food, and fresh air are of much more importance than climate. Unless a consumptive

delphia) is authoritative and most helpful in mastering the details of the treatment. The *Journal of the Outdoor Life*, New York City, is invaluable to consumptives. It contains advertisements of sanatoria and of clothing, chairs, and other articles used by consumptives.

has money enough to support himself without work and to give himself proper care, he should not leave his home for a distant state. For in many places consumptives are not welcomed, and it is better to be at home and have the proper care than to be without money or friends in the best climate in the world. In general, a cold, dry climate is best for consumptives, and they should avoid hot, moist climates and high elevations.

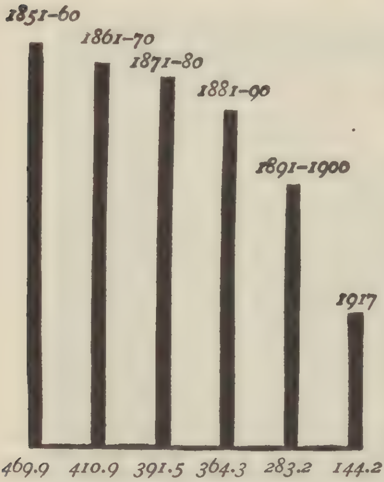



FIG. 48. Diagram showing the tuberculosis death rate in Massachusetts since 1851 for each 100,000 inhabitants.

**Sanatoria for consumptives.** Many states have established sanatoria to which consumptives can go and, at a slight expense, remain until they recover from the disease. This is sensible, for in a sanatorium a consumptive can have proper food and care at much less expense than he can have them at home, and in sanatoria the spread of the disease is stopped. It is much more economical for the people of a state to care for their consumptives in sanatoria than out of them, and it is much pleasanter and better for the patients. In checking the spread of tuberculosis, sanatoria have been a wonderful help — perhaps a greater help than any other one thing.

**Inheritance and consumption.** Consumption is often spoken of as an inherited disease, and it is true that some families are more afflicted by it than are other families. This does not mean that children in these families are born with tuberculosis germs in their bodies, but it means that they are born with less power of killing these germs than most people have. *People who come of consumptive families cannot have consumption unless they get tubercle bacilli into their lungs,*[1] and if they can avoid the germ, they may be as well and strong as any one. It should be understood that persons who move into houses that are infected with tubercle bacilli often contract the disease, although there may be no history of consumption in their families.

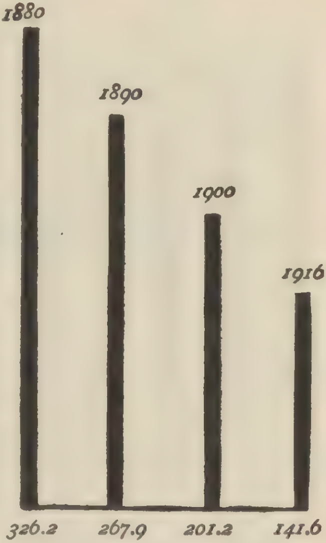



FIG. 49. This diagram shows the gradual decrease in the number of deaths from tuberculosis in the United States. The numbers given are the deaths per 100,000 in the part of the United States where statistics have been carefully kept.

**Hygiene and tuberculosis.** A quick disease like measles or smallpox cannot be prevented by hygienic living;

[1] A tendency to consumption may be inherited, just as a tendency to drunkenness may be inherited. But without whisky or other alcoholic drinks we can have no drunkenness, and without the tuberculosis germ we can have no consumption. — DR. ENNION G. WILLIAMS.

the germs attack so rapidly that the disease is on in full force before the body has time to manufacture substances to kill them. In tuberculosis the situation is very different. The body has plenty of time to work up its defenses, and even where the germs have begun to grow in the body they are checked and held in a harmless condition in the great majority of cases. It follows, therefore, that right habits of living and improving the conditions under which we live are a part of the fight against the disease. From 15 to 30 are the years when consumption is most common, and during this time of life special care should be used to keep the resistance of the body high. One important fact to remember is that after attacks of diseases like measles or typhoid fever the body needs special care until health and strength have returned in full.

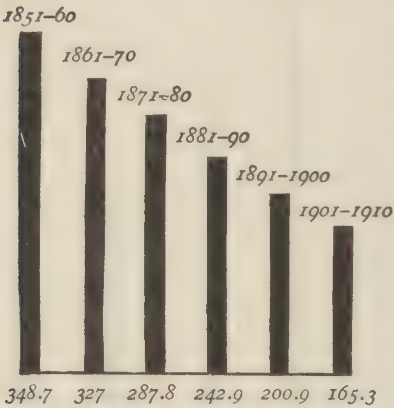



FIG. 50. This diagram shows the decrease in deaths from tuberculosis in England and Wales.

**Progress in the prevention of tuberculosis.** As we have seen, no germ has so spread itself through all society and has so extended its ravages to all parts of the world as has the tubercle bacillus. Yet the world is not full of tubercle bacilli. The air of the fields and woods, the streams of the forests and mountains, and the soil of

the fields, are free from them. The millions of people who in the past have died of tuberculosis germs got these

FIG. 51. Tent sanatorium for consumptives of the Modern Woodmen of America at Colorado Springs, Colorado. (*After a photograph.*)

germs from either sick cattle or sick men. Practically all the millions of people now living who are carrying these germs in their bodies were infected either by human sputum or by milk. Some persons, some cities, some states, and some nations have to a greater or less degree known these facts for some years, and in some places a warfare on the Great White Plague has been started. This warfare has been most successful. Examine Figure 48 and you will see that not one third so many people are now dying of tuberculosis in Massachusetts as died of it in that state sixty years ago. Examine Figure 49 and you will see that what is true of Massachusetts is true also, to a great extent, of other parts of the United States; and Figure 50 shows that not only in our own country but also in other countries

has this great enemy of mankind been checked. "Tuberculosis is communicable, preventable, and curable," is the battle cry of the anti-tuberculosis host, and in that host hope swells high in every breast, for already in many places the battle line of the enemy has been broken, and his forces are being driven back. Much of the work that is being done has as yet hardly begun to show its effects, but the results prove clearly that it is not necessary for people to die of tuberculosis as they are dying now.

### POINTS TO BE REMEMBERED

1. In curing consumption, the most important point is to begin treatment in the very early stages.
2. In its early stages consumption is curable.
3. Rest, food, and fresh air are the important factors in the treatment of the disease.
4. Climate is not so important in the treatment of tuberculosis as was formerly supposed.
5. Sanatoria are to be recommended because in them the patient can have the care that he needs, and in them there is no danger of the spread of the disease.
6. The germ of tuberculosis is not inherited, but some persons do inherit only a slight resistance to the germ.
7. A person who belongs to a consumptive family should take especial care to avoid the germ and to keep up his health.
8. Great progress has been made in the war against tuberculosis, and those who are fighting the disease are very hopeful for the future.

# CHAPTER FIFTEEN

## DUST AND GERM DISEASES

In a cubic yard of ordinary air there are from a hundred to a thousand bacteria. These bacteria are clinging to particles of floating matter of one kind and another; for they themselves are heavier than air, and by themselves they would fall to the earth like little stones. Air that is free from dust is therefore free from bacteria also, and by stirring up dust the number of bacteria in the air can be increased to a multitude. How very abundant small floating particles are in the air may be seen when a ray of sunshine enters a darkened room through a narrow opening.

**Disease germs in dust.** People who are forced to breathe dusty air always suffer greatly from sore throats, catarrh, bronchitis, pneumonia, and consumption. It was formerly believed that these diseases were air-borne, but later studies have shown that, generally speaking, the bacteria in the air are of harmless varieties; that disease germs die when they are exposed to light or thorough drying, and that dust under ordinary conditions is not an important carrier of germs. Nevertheless, it is true that in a weak light germs may remain alive in sputum or in mucus from the nose until these discharges are dry enough to be powdered up and blown about in the air. We cannot, therefore, say that indoor dust, such as is stirred up by sweeping a schoolroom, is always free from germs.

**How germs get into dust.** Practically all the disease germs that are in dust *have been spit into it by human beings*. If you will count up the dangerous germs that may be in saliva (the germs of consumption, pneumonia,

influenza, diphtheria, catarrh, bronchitis, colds, meningitis, infantile paralysis, whooping cough, scarlet fever, and measles), you will understand at once why every one should refrain from spitting on floors and in public

FIG. 52. In a light and well-ventilated room germs are killed by the light and drying.

places, especially in places where the sunlight has not an opportunity to kill the germs.[1]

**The greatest danger from dust.** Dust is dangerous chiefly, not because it carries germs into the air passages, but because it wounds the lining of the air passages and allows the germs that have already gotten into these parts in other ways to set up their growth. That this is the most important effect of dust is shown by the fact that dust that is absolutely free from germs, like that breathed in by stone cutters or metal grinders, causes those who breathe it in to suffer from respiratory diseases. Dust itself is, therefore, a cause of disease,

[1] According to the newer ideas of sanitation the chief danger in spitting lies in the fact that the germs in the fresh sputum are often carried about until they reach the hands and food of other persons.

and everything possible should be done to keep it from flying in the air.

**Keeping down dust.** Streets should be sprinkled, and where it is possible they should be cleaned by washing instead of by sweeping them. Houses should be swept with carpet sweepers or damp brooms, and some damp material should be used in sweeping schoolrooms and other public buildings.[1] Schoolrooms should be swept after school, so that there will be time for the dust to settle before the pupils assemble the next morning, and other public buildings should be swept some time before they are to be used. Dusting should be done with a damp cloth that will wipe off the dust and take it away, for it is simply foolish to stir up the dust into the air, where it will be inhaled or will settle again on objects in the room. In rooms that are much used, hard floors, rugs, and

FIG. 53. The wrong way to remove dust from furniture.

[1] The Michigan State Board of Health recommends the following preparations for use in sweeping the floors of public buildings: —

(1) To a pailful of sawdust wet with hot or cold water add one half pint of kerosene and a tablespoonful of sulpho-naphthol or formaldehyde.

(2) Heat one third part sand, and add two thirds part sawdust. To a pailful of this mixture add one half pint of paraffin oil (kerosene may be used) and mix thoroughly. This preparation produces excellent results.

(3) Boil one pound of sal soda and one pound of chlorid of lime (bleaching powder) in a gallon of water. Dampen sawdust to be used for sweeping with this solution. This preparation is excellent for restoring the natural color of floors.

plain furniture are more hygienic than heavy carpets and plush-covered furniture, because it is easier to keep them free from dust. Vacuum cleaners are recommended by health officials, because they remove dust and do not stir it up where it will be breathed into the lungs.

**Preventing dust in manufacturing processes.** Dusty trades (for example, pottery, metal grinding, stone cutting, and cotton weaving) are exceedingly unhealthful, and in some of these trades respiratory diseases (especially consumption) claim a majority of the workers unless measures are taken to guard against the breathing in of the dust. In some of the processes, the workman protects himself by wearing a mask, while streams of water used to keep down the dust and air blasts arranged to carry the dust away are each year saving hundreds of workers from death by diseases of the air passages and lungs. It is right that the workers in these trades should be protected; for dust, whether it be in the home, school, or factory, is a cause of disease.

## POINTS TO BE REMEMBERED

1. Bacteria are in the air only when floating matter or dust is in the air.
2. People who are forced to breathe dust suffer from respiratory diseases.
3. Indoor dust may contain disease germs.
4. The disease germs in dust come from the sputum of human beings.
5. Dust is dangerous chiefly because it wounds the walls of the air passages and allows germs to start their growth.
6. Every possible effort should be made to keep down dust.

# CHAPTER SIXTEEN

## THE ALIMENTARY CANAL

THE alimentary canal is a long passageway through the body. Its principal divisions are the mouth, throat, esophagus, stomach, small intestine, and large intestine. Like the air passages, the alimentary canal opens to the outside world and germs, therefore, easily enter it. The juices of the stomach contain an acid that keeps most bacteria from growing in that part of the alimentary canal, but in the long reaches of the small intestine a number of germs grow and cause disease.

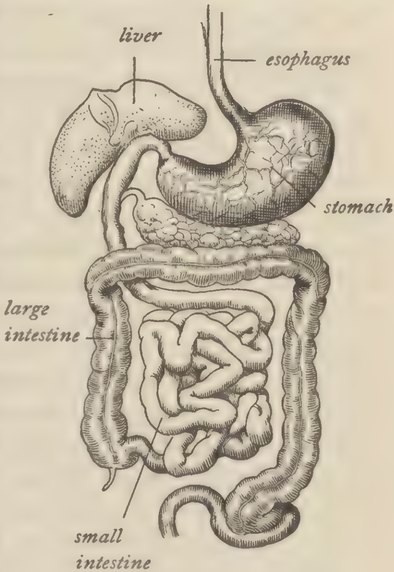


FIG. 54. The alimentary canal.

**Bacterial diseases of the intestine.** Among bacterial diseases of the intestine are typhoid fever, cholera, dysentery, diarrhea, and meat poisoning. This group of diseases causes yearly in the United States over 100,000 deaths, or about one thirteenth of all the deaths that occur; and of these 100,000 deaths about 70,000 are among children under two years of age. It should be understood that intestinal diseases are much more easily prevented than are respiratory diseases, for the

germs in most cases leave the body only in the intestinal wastes.

**Food poisoning.** Food poisoning is sometimes caused by bacteria of the typhoid group (page 82), but in our country it is usually due to a soil bacillus that is a relative of the tetanus germ. It gets into meat, fish, and canned vegetables and fruits, and, since it forms spores that are not killed except by considerable steam pressure, fruits and vegetables canned after being merely boiled may still be infected by it. It produces a most violent toxin, and it is the toxin that has been formed in the food before it is eaten, and not the germs, that does the damage. The toxin is destroyed by boiling, and any canned food that seems spoiled in the least should be cooked before it is even tasted, for death has followed tasting a spoonful of spoiled corn or "nibbling" a spoiled bean pod. Symptoms of the poisoning do not usually appear for from one to four days. Among the symptoms are great weakness, blurred vision, and paralysis of the throat. Limberneck in chickens is due to eating food infected by this same bacillus, and it is reported that forage poisoning ("blind staggers") in horses is caused by feeding hay and ensilage in which it has grown. An antitoxin has been prepared.

### POINTS TO BE REMEMBERED

1. Intestinal diseases cause more than 100,000 deaths in the United States each year.
2. These diseases attack children especially.
3. The germs are spread in the body wastes.
4. Most cases of food poisoning are due to toxin from a bacillus that grows in foods.

# CHAPTER SEVENTEEN

## TYPHOID FEVER

TYPHOID fever is found in all climates and in all countries where man dwells. It is usually a severe disease, but during some cases ("walking typhoid") the patient is hardly ill enough to go to bed. In the United States it is rapidly decreasing, but it still causes more than 15,000 deaths each year. The incubation period is from seven to twenty-one days.

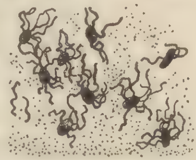


FIG. 55. The typhoid germ.

**Typhoid fever an important disease**. The importance of typhoid fever is not shown by the number of deaths that it causes. For every person who dies from typhoid fever there are six or seven others who must be watched over through the anxious weeks of an attack, and of these a considerable number rise from their sickness with weakened kidneys, lame backs, crippled limbs, or other injuries that last through life. There are at least 200,000 cases of this disease in the United States each year.

**The typhoid germ**. The germ of typhoid fever is a plump bacillus. It is fitted to live in a liquid, and swims freely. It enters the body through the mouth and attacks especially the walls of the small intestine, but in cases of typhoid the germ is found in the blood and all through the body. Meningitis, pneumonia, and ulcers in the bones are caused by this germ, and the "rose spots" that appear on the abdomen in most cases of typhoid fever are caused by the germs growing in the skin. The germs leave the body in the discharges

from the bowels and kidneys,[1] and occasionally in matter vomited by a typhoid patient. They may be in the perspiration, and if they are growing in the lungs, they will be found in the sputum.

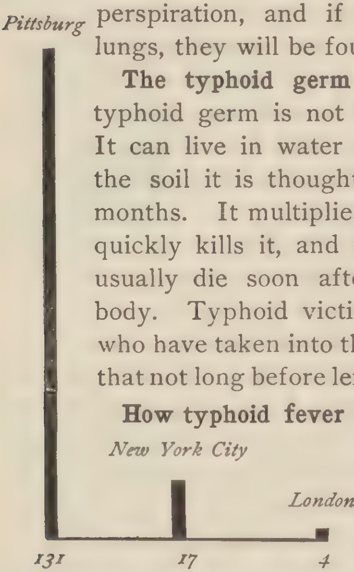



FIG. 56. Diagram showing the number of deaths from typhoid fever for each 100,000 inhabitants in Pittsburg, New York, and London in 1907. At that time the people of Pittsburg were drinking the polluted Ohio River water, New York had a good water supply, and London was using Thames River water filtered through beds of sand.

**The typhoid germ outside the body.** The typhoid germ is not known to attack animals. It can live in water for several weeks, and in the soil it is thought that it lives for several months. It multiplies rapidly in milk. Drying quickly kills it, and in general, typhoid germs usually die soon after they leave the human body. Typhoid victims are therefore persons who have taken into their mouths typhoid germs that not long before left the body of some one else.

**How typhoid fever is contracted.** Persons in the same house with a typhoid patient may get the germ on their hands by handling bedding or in a hundred other ways. Flies will carry the germs in great numbers if all wastes from a typhoid patient are not carefully destroyed. Occasionally the germs are in oysters that have been grown in polluted waters, and for this reason cooked oysters are safer than raw ones. In a

[1] In about 25 per cent of typhoid cases, the germs are in the urine, sometimes in enormous numbers (100,000,000 to 500,000,000 in a cubic centimeter, or 5,000,000 to 25,000,000 in a single drop). This must be carefully disinfected, or it will prove a most dangerous source of infection.

large number of cases, the typhoid germ has been carried in milk where some one having the disease has handled the milk, or where the milk vessels have been washed in water containing the germs.[1] In many other cases typhoid is contracted from water. In a later chapter we shall discuss the subject of disease germs in drinking water (page 86).

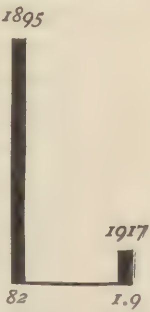



FIG. 57. In 1895 Chicago ran its sewage into Lake Michigan, from which its water supply was obtained. A drainage canal now carries most of the sewage away from the lake. The diagram shows the decrease in the death rate from typhoid fever, following the improvement of the water supply.

**Germ carriers.** It has been found that a considerable number of persons who have had typhoid carry the germs long after recovery from the disease. The germs usually locate themselves in the gall bladder and keep on passing into the intestine. One cook in New York gave the disease to twenty-seven persons in five years; a cook in Richmond, Virginia, gave the disease to ten persons in four widely separated houses. In one case the germs were found in the discharges from the body forty-two years after recovery from the disease. As yet it has not been possible to free these persons from the germs, and they are a constant source of danger to all about them.

[1] In 1907 a case of typhoid fever occurred in a mountain house near Palo Alto, California. The wastes from the patient were thrown into a stream on which a dairy was located some distance below. The milk cans at the dairy were washed in the stream, and a typhoid epidemic of 236 cases developed among the people who were supplied with this milk. In the spring of 1908 one milkman in Boston who was suffering with typhoid caused an epidemic of over 400 cases.

**The prevention of typhoid fever.** The great preventives of typhoid fever are pure water, pure milk, a safe method of disposing of human sewage, destroying carefully the germs that come from the bodies of typhoid fever patients and others who are carrying typhoid germs, removal of the breeding places of flies, and vaccination. In small villages and on farms, the great cause of typhoid fever is leaving human wastes exposed to flies (page 192). Vaccination against typhoid fever is now extensively practiced in armies, hospitals, communities where the disease is unusually prevalent, and among those who for any reason may run an unusual risk of being exposed to the disease. By vaccination the disease can be almost entirely prevented, and some health officers advise anti-typhoid vaccination for the whole population.

**POINTS TO BE REMEMBERED**

1. There are annually at least 200,000 cases of typhoid fever in the United States.
2. All cases of typhoid are caused by germs that have come from the human body.
3. The germs enter the body through the mouth, very frequently in water.
4. Some persons carry the germs long after they have recovered from the disease.
5. Pure drinking water, proper disposal of sewage, destroying all wastes that contain typhoid germs, and the removal of the breeding places of flies are the great factors in the prevention of typhoid.
6. Vaccination against typhoid fever is now successfully practiced.

# CHAPTER EIGHTEEN

## DISEASES CAUSED BY RELATIVES OF THE TYPHOID GERM

The causes of some of the germ diseases of the intestine are not well understood, as so many different bacteria are found growing in the intestine that it is sometimes impossible to be sure which one is causing the trouble. Among the germs frequently found in the intestine are several that are closely related to the typhoid bacillus. In this chapter we shall study some of the more important and best-known of these germs.

**The colon bacillus.** The colon bacillus is very much like the typhoid bacillus. It is always found in the intestine of man and of all the higher animals. Usually it feeds on the contents of the intestines and does no harm, but when the body is weakened (as by hot weather), or perhaps when a more powerful race of the germs gets into the intestine, the colon bacillus seems to be a cause of diarrhea and other troubles.

**The bacillus of dysentery.** *Chronic* dysentery is caused by a protozoön; this disease we shall study in a later chapter (page 131). The sudden attacks of *acute* dysentery, which sometimes run in epidemics, are caused by a bacillus that differs very little from the typhoid bacillus.[1] This is a severe disease, and one that is greatly feared by armies. In different parts of the United States there are epidemics of it every summer. The germs are scattered in the same ways that typhoid germs are scattered, and because the disease is a very dangerous one, all matter from a dysentery patient should be carefully destroyed.

[1] Acute dysentery is often called *flux*.

**Illness from germs of the typhoid group in foods.** One form of meat poisoning is due to a bacillus of the typhoid group that causes illness in cattle; horses, hogs, and goats. The germ is in the flesh before the animal is killed, and the flesh of sick animals should not be used as food. Meat infected with this germ has no odor and does not appear to be spoiled.

Many of the sudden outbreaks of diarrhea and intestinal trouble that are due to foods are believed to be due to other relatives of the typhoid germ. Sometimes they get into the food from people, but it is known that animals like the dog, cat, rat, and mouse carry germs of this group and it is believed that food is sometimes infected by these animals.

Rats in particular are unclean, destructive, and insanitary animals (pages 205 and 206), and they should not be allowed about human habitations or where human foodstuffs are kept. Directions for rat-proofing buildings may be obtained from the United States Department of Agriculture or from the United States Public Health Service.

### POINTS TO BE REMEMBERED

1. The colon bacillus is always found in the intestine and at times causes mild forms of disease.
2. Acute dysentery is caused by a bacillus that is a relative of the typhoid germ.
3. Food may contain dangerous germs of the typhoid group.
4. Germs of this group are carried by animals, and it is believed that food sometimes becomes infected from animals.

# CHAPTER NINETEEN

## OTHER BACTERIAL DISEASES OF THE INTESTINES

DIARRHEA and inflammation of the intestine are important causes of death, especially among young children. All together these troubles cause in our country over a

FIG. 58. In the Federal armies, during the four years of the Civil War, 110,070 soldiers were killed in action or fatally wounded. During the four years from 1903–1907, in the United States, 271,773 children under two years of age died from diarrhea and other similar diseases. The height of the child and the height of the soldier show the relative number of deaths in each case.

hundred thousand deaths a year. They are most to be feared in the summer, the time when children are weakened by the heat, and the time when germs multiply most rapidly in water and in foods. The germs enter the body in water, milk, and other foods. Flies are especially responsible for the spread of these diseases.

**Germs that cause diarrhea.** It seems probable that any one of several different kinds of bacteria may cause

diarrhea and inflammation of the intestine. In some cases pus-forming bacteria (sometimes streptococcus, sometimes Bacillus pyocyaneus) seem to be the guilty germs. In other cases it is probably the colon bacillus. Probably mild attacks of typhoid fever and dysentery are sometimes mistaken for simple diarrhea. The disease is infectious, and germs from a sick person should be destroyed.

**Weak and strong races of intestinal germs.** It is probable that among the germs that commonly grow in the intestine there are different races, some more powerful than others. It is also probable that new races of these germs give us more trouble than those to which we are accustomed; for water that does not seem to trouble those who use it daily will often start intestinal disturbances in visitors and travelers. This is probably because those who drink the water from day to day become accustomed to the germs in it and their systems learn to resist them, while a stranger is not prepared to overcome germs of these particular races.

**Cholera infantum, or summer complaint, in children.** It has not been possible to prove that any one germ is the cause of cholera infantum. In a number of epidemics the bacillus of dysentery has been discovered, but in many cases other germs seem to be the cause. The trouble seems to be that in summer babies are weakened by the heat until they have little resistance to germs, and at the same time the milk which is fed to babies is kept warm until it swarms with multitudes of bacteria of many different kinds. *To prevent cholera infantum the milk must be kept clean and cold*, and it should be used as fresh as possible. The milk vessels

and the bottles should be thoroughly washed and scalded to kill germs that are on them, and no impure water that is likely to contain germs capable of causing diarrhea should ever be given to a little child.

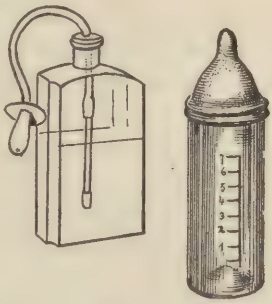


FIG. 59. The wrong kind of nursing bottle and the right kind. The bottle with the long, slender tube and the narrow mouth is hard to keep clean; the bottle with the wide mouth may be cleansed easily.

Indigestible foods that will lie in the intestine and form a breeding place for germs should not be given to young children. Children should be given all the fresh air possible, and their general health should be built up in every way, so that they will be able to resist germs. *It should be remembered that cholera infantum is infectious, and any person who is caring for a little baby should keep the baby away from the disease.* Isolating the patient and disinfecting the body wastes has proved one of the most effective methods of checking the spread of the disease.

## POINTS TO BE REMEMBERED

1. Diarrheas are caused by several different germs.
2. It is probable that there are weak and strong races of these germs.
3. Cholera infantum is generally caused by germs in milk.
4. Babies should be carefully looked after, so that they will be able to resist the germs of intestinal diseases.
5. Diarrheas and cholera infantum are infectious.

# CHAPTER TWENTY

## DISEASE GERMS IN WATER

THE disease germs that are most common in water are the germs of intestinal diseases. We shall therefore consider the question of a pure water supply. The importance of this subject is often not appreciated, for many people neither realize the great number of deaths that are due to impure water nor understand that it is possible to prevent most of these deaths.

**The importance of a pure water supply.** By filtering their water supplies through beds of sand, Albany, New York, and Lawrence, Massachusetts, have saved two thirds of the people who would have died of typhoid fever, if they had continued drinking impure water. Niagara Falls installed a water-purifying plant, and five years later its death rate from typhoid was only one eighth of what it had been when polluted river water was used. Certain towns in the Philippine Islands now use artesian water, and in those towns there are only about one half as many deaths as there were when impure water was used.


FIG. 60. For many years Pittsburg had the highest death rate from typhoid fever of any of the large cities of America. Can you tell why?

**Germ diseases that are contracted from water.** The diseases that are most frequently contracted from water are cholera, typhoid, dysentery, and diarrhea. The

germs of these diseases come from the bodies of human beings, reach water that is used for drinking purposes, and get back to the human mouth. In our country, typhoid fever is the most important of the water-borne diseases, although in the southern half of the United States dysentery and diarrheas are widespread and serious diseases.

Not only are the deaths from typhoid and other intestinal diseases reduced by using pure water, but for some reason a marked decrease in the number of deaths from pneumonia, tuberculosis, and several other diseases seems to follow changing from impure to pure water. The reason for this decrease is not yet fully understood. It is known, however, that in pneumonia, influenza, diphtheria, and tuberculosis the germs are practically always in the wastes from the alimentary canal, and tubercle bacilli have been found in the water of a stream that received the drainage of a tuberculosis sanatorium. It seems probable that the germs of respiratory diseases live in water and that many persons contract these diseases through impure drinking water.

**How disease germs get into drinking water.** Usually, disease germs either get into water from sewage or are washed into the water from soils that have been polluted with wastes from the human body. They may get into a well or cistern if a person who has germs on his hands works around the pump or handles the water buckets; a stream may be polluted by washing clothes from a diseased person in it, or by a diseased person bathing in it; but in general, disease germs are washed out into waters from polluted soil. The following history of the typhoid epidemic that occurred in Plymouth,

Pennsylvania, in 1885, shows how the water supply of a town may be infected with germs. During the winter of 1884–85, a man living on the bank of a stream that flowed into the town reservoir was stricken with typhoid fever. The wastes were thrown out on the snow, and in the spring the waters from the melting snows and the rains washed these germs into the water supply of the town, and typhoid fever suddenly broke out. The city had a population of about 8000, and during the height of the epidemic from 50 to 200 persons a day were attacked. All together there were 1104 cases and 114 deaths. People who drank from wells escaped, and there is no doubt that the germs came from the public water supply.

Epidemics like the one in Plymouth are, of course, uncommon, but if you will investigate you will probably find that in the town or community in which you live, several persons die each year from diseases that are mainly due to water.

**Dangerous waters.** Any water that comes from the surface of the ground is likely to contain disease germs. Shallow wells, springs, and small streams are the most dangerous of all waters. It is not safe to use water from these sources, no matter how clear and pure it may seem; for in the country, where people drink chiefly from wells, typhoid fever is more common than it is in our most crowded cities, and in the mountain regions, where the people drink from the most beautiful clear springs and streams, typhoid is a great scourge. Experience shows that intestinal diseases follow the drinking of surface water, and it is not the part of wisdom to fail to profit by the experience of those who have lived before us.

**Safe waters**. In general, waters that do not come from the surface of the ground are safe. Deep artesian wells (except in rare instances in mountain regions) furnish water that is absolutely safe. Rain water that is caught and stored away in tanks above the ground is safe also. There is a common idea that dangerous germs may be blown up on a roof in dust, but the germs of intestinal diseases die if they are thoroughly dried, and are not found in rain water that has been kept from touching the ground. Underground cisterns that are thoroughly cemented are much safer than wells. Yet there is danger of ground water getting into a cistern around the top, or if part of the pipe that carries the water from the roof is underground, germs may easily get into the cistern through this pipe. There is also danger of germs falling into an underground cistern from the platform above. Distilled water is perfectly safe, but some bottled spring waters contain bacteria.

**Keeping germs out of wells**. In country regions wells will probably be the principal source of drinking water for many years, and it is important that they be made as safe as possible. In guarding a well from dangerous germs, the following are the chief precautions to be taken: —

*Keeping surface water out of wells*. Very few bacteria live deeper than three or four feet in the ground, and water, as it comes from the ground into a well that is as much as twenty feet deep, is usually free from germs. In most cases the pollution of the water in such a well comes from the surface water getting into the well when it rains and carrying with it germs from the upper layers of the soil.

To keep a well free from dangerous bacteria, it should first of all be located on high ground and away from all pigpens, stables, or other outbuildings. Under no circumstances should any puddles of water be allowed near it. Around the mouth of the well a tough clay should be spread and packed in thoroughly.

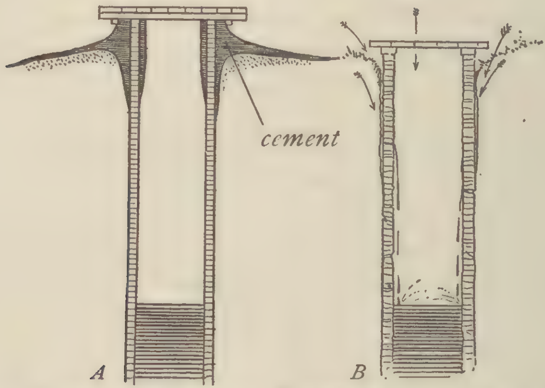
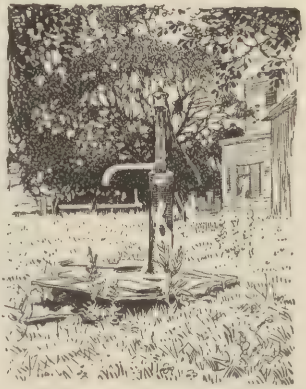



FIG. 61. *A* shows a well so arranged that surface water and germs are kept out of it. *B* shows how surface water and germs get into a well.

to form a water-tight layer over the soil. This should slope so as to carry all water away from the well. The whole task is to keep surface water out, and this can be done still better by cementing the upper part of the wall and laying a circle of cement over the surface of the soil, as is shown in Figure 61. The platform should be wide enough to keep any surface water whatever from running down in behind the wall and getting into the well.

The above precautions will do much to keep out of a well not only bacteria that are in the soil, but matter on

which bacteria can feed and multiply. Yet if the earth about a well is polluted (as it is in thickly settled regions where there are many dry closets), some germs are certain to find their way into the water. For this reason it has often been necessary in towns and cities to fill up

FIGS. 62 and 63. From which well would it be safe to drink the water?

wells, and where there is reason to think that a well has been the cause of disease, the use of water from it should certainly be stopped.

*Keeping germ carriers away from wells.* No person who is sick, or who is caring for a case of infectious disease, should work with well buckets or about a pump. Neither is it safe to use water from a well where many people handle the rope and buckets, for we are finding that germ carriers among healthy people are so common that there is always danger that one of them may have been about the well. Any person who walks over ground that has been polluted with human wastes (as

many dooryards are) and then stands on a well platform, may leave disease germs where they will get into the water. For this reason, a well should always have a clean, sound platform, built of two layers of boards to make it as nearly water-tight as possible, and the pump should be so arranged that water will not run back into the well around it. A well that is covered by a small house and from which water is pumped by a windmill is much easier to make safe than one in the open, from which the water is taken by a hand pump or drawn out by buckets.

**Freeing water from disease germs.** It is the duty of every city either to secure pure water for its inhabitants, or, by filtering or in some other way, to remove dangerous germs from the water that it sends to the homes of its people. Many cities fail to do this, however, and when one is compelled to use impure city water or water from an ordinary well or spring, the best plan is to boil it. Simply bringing it to the boiling point will kill all dangerous germs (page 158). Most house filters are almost useless, and some of them are worse than useless, for they catch and hold matter in which bacteria breed and multiply, and the bacteria pass through the pores in most of them. Very fine porcelain filters, if they are carefully cleaned and attended to, do strain out bacteria, but they work very slowly, it is a great deal of work to care for them, and it is easier to boil water than to look after one of them. Filtering through animal charcoal takes certain coloring matter out of the water and makes it look clear and bright, but it does not remove germs. It is always to be remembered that to use fruits, vegetable dishes, or milk vessels that have been

washed in impure water may be as dangerous as to drink the water. Bringing water to the boil will make it safe for drinking purposes.

**The danger of bathing in polluted water.** When a person bathes in polluted water he of course gets whatever germs are in the water on his hands and face and probably also in his mouth. For this reason it is not well to swim in polluted water, and swimming pools are a real danger when constant attention is not given to their cleanliness and the disinfection of the water. The water in a swimming pool is usually disinfected with chlorin or a compound of lime that contains chlorin.

FIG. 64. Water like this is free from disease germs unless it has been polluted by wastes from the bodies of the sick.

**Clear water not necessarily safe.** Because the water in a well is clear or because people have been drinking it for a hundred years does not mean that it is safe. Germs are so small that they cannot be seen by the unaided eye, and it is possible for a well to have been in good condition twenty-five years ago and to be receiving

surface water now. It is possible, too, that many of the people who have drunk water from the well during the hundred years have died of diseases that they contracted from the water. Do not make the mistake of thinking that a well can be made safe by cleaning it out occasionally. Typhoid germs live longer in clean water than in dirty water, and a well can be made safe only by keeping disease germs out of it.

### POINTS TO BE REMEMBERED

1. Nothing is more important in preventing germ diseases than pure drinking water.
2. Intestinal diseases in particular are spread through water.
3. The disease germs in water come from the human body.
4. They get into the water from germ-laden wastes, from the hands of germ carriers, and in other ways.
5. Great epidemics of typhoid fever and cholera have been caused by polluted water.
6. Water from the surface of the ground (water from streams, springs, and shallow wells) is unsafe for drinking.
7. Artesian water is usually safe, as is rain water that has been kept free from pollution.
8. To keep wells free from germs, surface water and dirt from the platform must be kept out of them, and persons who are carrying germs should be kept away from them.
9. It is dangerous to bathe in waters polluted with sewage or in swimming pools that are not kept disinfected.
10. Clear water is not necessarily safe.

# CHAPTER TWENTY-ONE

## OTHER BACTERIAL DISEASES

BESIDES the diseases we have already studied, there are many other diseases of man that are caused by bacteria. Most of these are tropical diseases, and we shall not even mention them here. In a considerable number of other diseases the particular germ that is responsible has not been surely determined, and we cannot tell whether these diseases are due to bacteria or to protozoa. There is also a great number of bacterial diseases of animals, and a considerable number of bacterial and fungous diseases of plants, for animals are seldom sick, and plants are almost never sick, unless they are attacked by germs. In this chapter we shall take up a few very different diseases that it is well to understand.

### MENINGITIS

Every year there are in the United States over 10,000 deaths from meningitis. The disease is caused by germs growing in the membranes around the brain and spinal cord. About two thirds of all cases of this disease are caused by pus-forming bacteria, the pneumonia germ, the influenza germ, the tuberculosis germ, or the typhoid germ. The other cases of meningitis are caused by a special germ (*Meningococcus*)[1] that is not found in other diseases. When meningitis is caused by this germ, it is an infectious disease, often runs in epidemics, and is sometimes called epidemic cerebro-spinal meningitis. Its attack is sudden and severe, and until very recently most cases ended in death.

**How the germ of epidemic meningitis enters the body.** The germ of epidemic meningitis is abundant in the dis-

[1] Pronounced men-in′-go-kok′-kus.

charges from the nose of a patient who is suffering with the disease. It dies quickly from drying, and does not grow naturally in animals or outside the human body. It is spread in ways that do not require it to be long outside the body, as by handkerchiefs, drinking cups, the hands, or by droplets that have been coughed or sneezed out into the air. It is sometimes found in the noses of persons who have been about meningitis patients, and it is believed that it reaches the brain by working upward through the roof of the nasal chambers. Any one who is carrying this germ should be quarantined, and the sputum and discharges from the nose of a meningitis patient should be carefully destroyed.

FIG. 65. The germ of epidemic cerebrospinal meningitis.

**Curing meningitis.** Recently a serum prepared from the blood of the horse has been used in the treatment of epidemic meningitis.[1] This serum contains both an antitoxin and a substance that kills the meningitis germs. It is proving of great value, for of 1294 patients that were treated with it only about 31 per cent died, while of cases that are not treated with the serum, about 70 to 75 per cent end fatally. Like the antitoxins for diphtheria and tetanus, meningitis serum should be used as early in the case as possible.

## SORE EYES

Different germs—the diphtheria, the pneumonia, or the pus-forming bacteria—may cause sore eyes, but

[1] This serum is of no value in cases of the disease caused by germs other than the meningococcus.

there is a particular bacterium (*Koch-Weeks bacillus*) that causes the epidemic form of sore eyes often called "pink eye." This germ dies quickly from drying, and is not found to any extent in dust, but it is easily transferred on handkerchiefs, towels, wash basins, on the hands, and by flies, and children with this disease should not attend school. The infected eye should be carefully covered to keep germs from getting into the other eye. It is never safe to wash the eyes in a public wash basin or to wipe them on a public towel (page 197). Any infection of the eyes should be promptly treated by a physician, for continued inflammation may injure the blood vessels and linings of the eyelids.

FIG. 66. The bacillus that causes "pink eye."

## RHEUMATISM

Acute rheumatism is caused by bacteria that settle in the joints and cause inflammation there. The germ has been thought by some to be a variety of streptococcus. Others think that while it is very similar to streptococcus, yet it is a different germ. When it attacks the valves of the heart, it may cause death.

## LEPROSY

Leprosy is caused by an exceedingly slow-growing bacillus that is similar in many ways to the bacillus of tuberculosis. The germ probably gets into the body by being inhaled, or through wounds, or possibly by the bite of the mosquito. It is believed that several lepers have been cured by the use of a new remedy.

### BUBONIC PLAGUE

Bubonic plague is the disease that in the Middle Ages was called the Black Death. The germ attacks rats as well as men, and men usually get the disease from the bites of fleas that have been living on plague-stricken rats. Recently there has been a widespread epidemic of plague in the world, the disease being in all the continents and in one year in fifty-two different countries. It is most severe in India, where in 1907 it caused nearly a million deaths. In the United States, plague succeeded in landing in San Francisco, Seattle, and New Orleans. In the cities it was soon exterminated among the rats, but in California it spread to the ground squirrels and is still being fought among them. The disease spreads from one country to another by infected rats traveling by ship, and many of our seaports are now rat-proofing the wharves along their water fronts in order to guard against the introduction of this dreaded disease (page 205).

### CHOLERA

The cholera germ grows in the intestines and produces a toxin so powerful that death sometimes comes in a few hours. The germs are spread in the same ways that typhoid germs are spread. At the present time cholera is feared only in those countries where the germ theory of disease is not understood. In all countries where people understand the germ theory of disease, cholera has now disappeared.

### MUMPS

It is believed that the cause of mumps is a small coccus that grows in the salivary glands. The incubation period is from thirteen to twenty-one days, and the patient is

dangerous to others for a week after the swelling of the glands is gone.

## BACTERIAL DISEASES OF PLANTS AND ANIMALS

**Bacterial diseases of animals.** Among bacterial diseases of animals are the following: Swine plague among hogs; roup, white diarrhea, and cholera among fowls; milk-sickness and black-leg among cattle; distemper and glanders among horses; Malta, or Mediterranean, fever, among goats and cattle; and many other diseases of animals that cannot be mentioned here. The glanders bacillus may attack man (sometimes causing a fatal illness), and milk-sickness and Malta fever may be contracted by man from milk.

**Bacterial diseases of plants.** Pear blight; a disease much dreaded by orchardists, called crown-gall; the wilt disease of young cucumbers, melons, squashes, and pumpkins; the brown rot of the potato, tomato, and eggplant; the black rot of cabbages, rutabagas, and turnips; a disease of sweet corn; a knot disease of the olive; a rot of the calla lily; and a widespread stem rot of the potato — all these are plant diseases that are caused by bacteria. It is thought that bees carry pear-blight germs from tree to tree during blossoming time, and that they are entirely responsible for the spread of the disease. The germs of wilt diseases are probably spread by beetles and squash bugs that feed on the diseased plants.

FIG. 67. A muskmelon plant that has been attacked by wilt bacteria.

**Diseases caused by fungi.** Many diseases of plants — rusts, smuts, mildews, many of the rots, and various other diseases — are caused by small plants (fungi) that are similar to molds. These fungi are much larger than bacteria, their bodies being composed of long, thread-like filaments. A few fungi enter the hair follicles and grow in the human skin. Among the diseases caused by them are ringworm, tetter, barber's itch, and a kind of itch that attacks any part of the body. These diseases are infectious, and care is necessary to prevent their spread. Thrush, a white growth found in the mouths of young babies, also is caused by a fungus.

### POINTS TO BE REMEMBERED

1. Meningitis may be caused by any one of several germs, but the epidemic form of the disease has a special germ of its own.
2. In epidemic cerebro-spinal meningitis, the germ is in the discharges from the nose of the patient and enters the body through the nose.
3. A new serum is proving very valuable in treating this disease.
4. Great care should be taken to guard the eyes when sore eyes are epidemic, and all cases of infectious sore eyes should be quarantined.
5. Acute rheumatism, leprosy, plague, and cholera are bacterial diseases.
6. Bacteria cause many diseases of animals and plants.
7. Many plant diseases and some skin diseases in man are caused by fungi that are larger than bacteria.

# CHAPTER TWENTY-TWO

## PROTOZOA

THE bacteria are the smallest of all plants. The protozoa are the smallest of all animals. The smallest protozoa look like tiny specks under the most powerful microscope, and are no larger than very small bacteria. The largest of them are much larger than any bacteria, but they can barely be seen with the naked eye.

Protozoa are abundant in both fresh and salt water. Many of those that live in the ocean have shells, and so

FIG. 68. Phosphorescence in the water is caused by multitudes of protozoa.

abundant are they that great beds of chalk and limestone are built by them. Others are phosphorescent (give off light), and in the warmer seas the waves at night are often fringed with light from the multitudes of protozoa in the water.

Many kinds of protozoa live in the bodies of animals, and almost every animal, from worms and insects up to man, suffers from diseases that are caused by them.

Among the protozoan diseases of man are several that are carried by insects, and these diseases are worse in

FIG. 69. Shells of protozoa in a piece of chalk as seen under a microscope.

the warmer parts of the earth, where insects are most abundant.

In the following chapters we shall consider protozoan diseases and, along with them, several diseases due to very small germs that may or may not belong in the protozoan class (page 194).

#### POINTS TO BE REMEMBERED

1. Protozoa are very small animals.
2. Protozoa are abundant in both fresh and salt water.
3. They cause many diseases of animals and men.
4. Several protozoan diseases are spread by insects.

# CHAPTER TWENTY-THREE

## MALARIAL FEVER AND YELLOW FEVER

MALARIAL fever does not cause so many deaths as some other diseases, but because it is found over a great part of the world, and because in malarial countries a great number of people are affected by it for long periods of time, malaria must be counted as one of the most important of the diseases that afflict mankind.[1] No community can prosper as it should while its people have malaria, for a person who is suffering from this disease cannot have the energy and ambition that he should have to carry on his work.

**The germ of malaria.** Malaria is caused by small protozoa that live in the red blood corpuscles. A malaria germ grows and becomes larger in a corpuscle and then divides into a number of parts, each of which is a young germ. The corpuscles then break into pieces, leaving the young germs free in the blood. Each young germ now enters a fresh red corpuscle, grows in it, and divides into a number of germs. These young germs then break forth and attack other corpuscles.

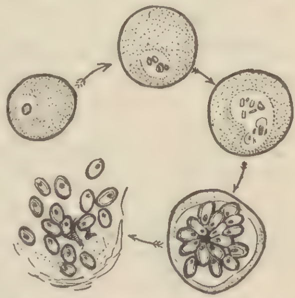


FIG. 70. The growth of the malaria germ in a red blood corpuscle.

**The cause of the chill in malaria.** While they are growing in the corpuscles, the malaria germs produce

[1] In malarial regions 50 per cent of the people may have the germ of malaria in the blood. Almost one half of these do not have chills and fever, but they are suffering from a slow, chronic form of the disease that robs them of their strength. It has been calculated that in a severe case of malaria there may be a pint of the germs in the blood.

toxin. When the corpuscles break down at the time the germs come out into the blood, a large amount of toxin is set free in the blood at one time. This toxin poisons the cells of the body and brings on the chill and fever. There are several different kinds of malaria germs, and the chill comes every day, every other day, or every third day, according to the length of time it takes for the germs to become full-grown and break out of the corpuscle. In their growth the malaria germs destroy great numbers of red blood corpuscles, and the loss of these millions of corpuscles, as well as the poisoning of the cells by the toxin, injures the body.

**How the malaria germ gets into the body.** The malaria germ grows in a certain kind of mosquito (page 112) as well as in man, and it gets into our bodies from the bites of these mosquitoes. When the mosquito feeds on man, it thrusts its proboscis (bill) down through the skin and sucks out the blood. When a mosquito draws blood from a person who has malaria, it takes malaria germs into its stomach with the blood. These germs pass into the walls of the mosquito's stomach and multiply in little sacs on the outside of the stomach walls. The sacs then burst, and great numbers of the germs pass through the mosquito's body to the salivary glands. The germs appear in the saliva in about ten days from the time when they were first taken into the stomach.

FIG. 71. The stomach of a mosquito that is infected with malaria. The malaria germs grow in the sacs on the mosquito's stomach.

Now the opening in the proboscis of the mosquito is too small to allow the blood corpuscles to pass up

through it, and when the mosquito bites it injects saliva into the wound.[1] The saliva breaks up and dissolves the corpuscles, and the mosquito is then able to draw out the blood. If the malarial germs are in the salivary

FIG. 72. Diagram of a mosquito's body. The malaria germs pass from the stomach to the salivary glands. Then they are injected through the proboscis into the persons whom the mosquito bites.

glands of the mosquito, they will, of course, be injected into the wound with the saliva. Unless the body is able to destroy them, the germs then enter the red corpuscles, and in about a week from the time the man was bitten the disease appears.

**Malaria spread only by mosquitoes.** It is a common idea that malaria is caused by drinking impure water or by "miasmas," or poisonous vapors, from swamps or damp ground. This idea is not correct. In Italy many

[1] It is the poisonous saliva of the mosquito that causes the itching and swelling that follow a mosquito bite.

experiments have been made, during which persons drank water from the worst malarial marshes in Italy and Sicily, and inhaled the air of the marshes. Not a single case of malaria ever followed these experiments. Near Rome, in a hut that stood in the very midst of the Pontine marshes (one of the worst malaria-stricken regions in the world) two English scientists lived for several months during the worst of the malaria season. They breathed the air that came from the damp lowland on which the house stood, and drank the water of the region that was supposed to cause malaria. In every way they lived as the people about them lived, except that in the evenings they retired to their carefully screened hut before the mosquitoes came out, and stayed behind their screens until the sun was up and the mosquitoes had retired. These men had no symptoms whatever of malaria, although the people all about them were suffering from the disease.

FIG. 73. By screening themselves from mosquitoes, two Englishmen lived for several months in one of the worst malarial regions in all Italy, without symptoms of the disease.

At the same time mosquitoes were caught in Italy, and, after they had been allowed to bite a malaria patient, were sent to London. There a physician who lived in England and who had never had malaria allowed them to bite him. In a short time he developed a case of Italian malaria and the germs were found to be abundant in his blood. These and a large number of other

similar experiments leave no room to doubt that it is by the bite of the mosquito and not by water or by damp air that the malaria germ enters the body.


FIG. 74. Germs of malaria were sent from Italy to England *in a mosquito*, and a physician who was bitten by the mosquito developed malaria.

**Killing malaria germs.** There is no medicine known that will kill the germs of most diseases after they get into the body, without at the same time killing our own cells. Fortunately for us, the human body usually can endure an amount of quinine that will kill the germs of malaria. There is therefore, in ordinary cases, a cure for malaria.

**Preventing malaria.** It is better to prevent any disease than to try to cure it, and it is better to prevent malaria than to try to kill the germs after they get into the body. The following are the best ways of preventing the spread of malaria: —

*Screening malarial patients from mosquitoes.* Mosquitoes that have not bitten persons who have malaria are free from the germs, and cannot spread the disease. But it has been found that in a house where there is a malaria patient the mosquitoes are usually infected and are able to give the disease to others. In regions where there is only an occasional case of malaria, or where only a few persons are living close together (as in a country farmhouse), much can be done to check the spread of malaria by keeping patients under mosquito nets until the germs disappear from the blood (page 203).

*Avoiding unnecessary exposure to mosquitoes.* Persons living in malarial regions should keep their houses carefully screened, and should sleep under mosquito nets during the mosquito season. They should visit houses that contain infected mosquitoes only in the middle of the day. They should remain indoors in the morning and evening, when mosquitoes are active, and on cloudy days they should keep away from woods and swamps where mosquitoes are flying. Care should always be taken in selecting places for camping and fishing trips, for one night spent among mosquitoes may start an attack of malaria that will last for months.

*Destroying mosquitoes.* In towns and around country houses that are at all favorably located, mosquitoes may be destroyed by removing their breeding places. So well do we understand how to do this that there is now little reason why one who does not live in a swampy region should have malaria. The best ways of destroying mosquitoes will be discussed in the next chapter.

**The use of quinine.** In some rural regions it is impossible to destroy all the mosquitoes, and a more hopeful method of attacking the malaria problem seems to be by the examination of the blood of all the people and treating with quinine those in whose blood the germs are found. Recent experiments indicate that it is possible by long and thorough quinine treatment of malaria patients to free all the people of a region from the germs of the disease. In this way not only those who are afflicted with malaria are cured, but it is made impossible for the mosquitoes to become infected and the disease dies out. Small doses of quinine should be taken daily as a preventive of malaria by those who are exposed to the disease.

### YELLOW FEVER

The germ of yellow fever has not been discovered (page 194). It is known, however, that the disease is spread only by a mosquito of a certain kind (Fig. 81). By screening yellow fever patients, by quarantining, by killing infected mosquitoes in houses where the disease has appeared, and by removing the breeding places of mosquitoes, the disease can be controlled. In our own country it will never again be allowed to spread.

FIG. 75. Dr. Walter Reed. On the tablet marking his grave is the inscription: "He gave to man control over that dreadful scourge, yellow fever."

**POINTS TO BE REMEMBERED**

1. Because of the great number of persons who are attacked by it, malaria is a very important disease.
2. The malaria germs grow in the red blood corpuscles.
3. They break forth from the corpuscles at the time of the chill.
4. The malaria germ is carried only by one kind of mosquito.
5. The malaria germ is one of the very few germs that may be killed with medicine after it gets into the body.
6. Malaria may be prevented by screening malaria patients, by avoiding exposure to mosquitoes, by destroying mosquitoes, and by the use of quinine.
7. Yellow fever is contracted only from the bite of a mosquito.

# CHAPTER TWENTY-FOUR

## MOSQUITOES

THE mosquito, more than any other one agency, has driven man from the warmer and more fertile portions of the earth to the colder and more barren regions. It carries not only the germs of malaria and yellow fever, but also the germs of dengue, or "break-bone" fever, and a small worm (*Filaria*) that lives in the blood and causes an enormous swelling (*elephantiasis*) of the limbs or other parts of the body. The two latter diseases are common in the tropics and both are found to a certain extent in some of our southern states. The germs of several diseases of man not found in our country, and of certain diseases of birds, also are carried by mosquitoes. Where it is possible to do so, the best way to end all these diseases is to destroy the mosquitoes. To work at this intelligently it is necessary first to know the life history and the habits of the mosquito.


FIG. 76. *A* is a raft of mosquito eggs; *B* is a single egg.

**Life history of the mosquito.** The mosquito lays its eggs on water. In about a day the egg hatches into a *larva* (commonly called a *wiggler* or *wiggle-tail*) that swims about actively in the water. The larva takes in air through a breathing tube, which it thrusts out through the surface of the water to the air, as shown in Figure 77. In from seven to fourteen days the larva changes its form. The head and the fore part of the body become much heavier, and the breathing tubes shift to the back of the body. In this stage it is called a *pupa* (commonly called a *tumbler*, because, instead of wriggling as it

swims, it tumbles over and over). In from two to five days — ten to twenty days from the time the egg was laid — the pupa splits down the back, and the adult mosquito comes out and flies away.

In the larva and pupa stages, mosquitoes feed on small plants and animals that are in the water. In the adult form, they live chiefly by sucking the juices from plants, but they eagerly attack animals and suck the blood from them when there is an opportunity to do so. How long a mosquito naturally lives in the adult form is


FIG. 77. *A* is a mosquito larva; *B* is a pupa; *C* is an adult mosquito coming out of an old pupa.

not known, but one has been kept for seventy-six days, and considerable numbers of them live through the winter, hidden away in crevices and cracks. The young and the eggs of the mosquito are not killed by being frozen, and mosquitoes often come out in the spring from eggs or larvæ that have lived through the winter.

**Anopheles.** The kind of mosquito that carries the germ of malaria is called *Anopheles* (a-nŏf′-ĕ-lēz). It is

an almost silent mosquito, that does most of its biting in the early part of the night and early in the morning. It can readily be distinguished from other mosquitoes by the black spots on its wings, and by its habit of elevating the back part of the body, or standing up on its head, when resting and biting. Other mosquitoes


FIG. 78. *A* is the Anopheles mosquito (the mosquito that carries malaria), showing its position while resting, and the spots on its wings. *B* shows the common mosquito (Culex).

are often carried considerable distances by the wind,[1] but the Anopheles has a habit of clinging to weeds, shrubs, and bushes when the wind blows, and is not often found far (seldom more than a few hundred yards) from the place where it is hatched. The mosquitoes that give people malaria are usually[2] raised by those same people, or by their neighbors.

[1] There are some mosquitoes that breed in salt marshes and travel for miles. These rarely enter houses, and they do not carry malaria.

[2] The yellow fever mosquito is a domestic mosquito and breeds almost entirely in water about houses. The Anopheles, on the other hand, is a half-wild mosquito, and likes best to breed in the fields and woods, in ponds, small streams, and ditches.

**Destroying the breeding places of mosquitoes.** The first thing in the fight with mosquitoes is to deprive them of breeding places near human dwellings. An old fruit can may catch and hold enough rain water to breed a large number of mosquitoes; in the course of a summer, an almost unlimited number[1] can come from a water barrel or an open cistern; and an undrained ditch by the roadside may supply enough mosquitoes to torment and infect with malaria all the people in the vicinity.

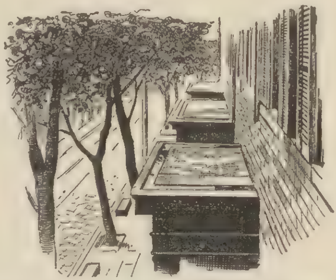


FIG. 79. The gutter over this doorway became stopped up with leaves, and in the water that stood there, hundreds of mosquitoes were hatching. (*After photograph by the Richmond Board of Health.*)

Old cans and pans should be cleared away; water barrels, tanks, and cisterns should be screened so that the mosquitoes cannot get to them to lay their eggs; sagging eave troughs should be braced up so that no water will stand in them, for in an eave trough the larvæ may start in a very small quantity of water and then be washed down into the cistern, where they will complete their development. All pools and puddles about houses should be drained; and wells must be watched and if necessary covered, for sometimes the larvæ are found in wells. Weeds and shrubbery in which the mosquitoes can find a dark, cool place to hide during the hot part of the day, or when the wind blows, should be cut

[1] Nineteen thousand eggs and young mosquitoes have been found in a rain barrel at one time.

down. As long as mosquitoes are found about the house, the work should be continued, for if all breeding places near houses are removed, Anopheles mosquitoes and generally all other mosquitoes will disappear. The work of destroying mosquitoes in cities and towns must be taken up by public officials who have authority to compel every one to remove the breeding places on his premises.

**Killing mosquito larvæ with kerosene.** When pools of water cannot be drained, it is an easy matter to kill all

FIG. 80. This house was so infested with mosquitoes that the owner was about to sell it at a sacrifice, when he learned from a health official that a half-hour spent in draining the ditch or in sprinkling it with kerosene would free his family from annoyance and the danger of disease.

young mosquitoes in them by pouring a little kerosene on the water. This forms a film over the water, shutting the larvæ off from the air, and killing them in a few minutes. If the kerosene is washed away by rains, it must be renewed within ten days, for this is about the time it takes a mosquito egg to grow into a mosquito. Minnows, goldfish, and other small fish feed on the

mosquito larvæ, so by introducing these into a pond, the number of mosquitoes that breed there may be greatly lessened.

**Killing adult mosquitoes.** After mosquitoes have been allowed to hatch and scatter themselves, it is hard to get rid of them, but when mosquitoes in a house are known to be infected with yellow fever or malaria, it is very important to kill them at once. This is usually done by burning sulfur in the rooms that contain the mosquitoes.[1] In fighting diseases that are spread by mosquitoes, the importance of screening sick persons who may infect the mosquitoes with germs must not be forgotten. Where mosquitoes are plentiful, often the only way by which an individual can protect himself is to screen his house and bed and stay indoors when the mosquitoes are abroad.

FIG. 81. The yellow fever mosquito (Stegomyia). This mosquito has light bands around the body and on the legs. It breeds near houses and does not fly far from where it is hatched.

**Communities that have successfully fought mosquitoes.** It is a very easy matter, and not at all expensive, to banish mosquitoes almost completely from a town near which there are no extensive natural breeding places.

[1] The fumes of burning sulfur kill flies, fleas, and bedbugs, as well as mosquitoes, but they destroy the color in carpets and other cloth articles, and blacken the gilt on picture frames, book covers, and furniture. Burning insect powder (*pyrethrum*) will stupefy flies and mosquitoes so that they can be swept up and burned.

Even in regions where there are large marshes and many streams and ponds, by systematic work communities can free themselves from mosquitoes. This has been done in Panama, Cuba, Brazil, and elsewhere in the tropics, and the inhabitants of the North Shore of Long Island and of certain towns in New Jersey, where the mosquitoes were formerly so abundant that they were a veritable pest, have now conquered their winged enemies. In this book there is not space to tell of the work that has been done in these places, but from the Department of Agriculture at Washington, D.C., and from state and city boards of health, bulletins can be obtained that give many interesting facts about mosquitoes, with directions for fighting them.

### POINTS TO BE REMEMBERED

1. Mosquitoes carry malaria and yellow fever.
2. In ten days the mosquito can pass through the larva and pupa stages and come out in the adult form.
3. The mosquito that carries malaria has spotted wings, and when resting stands upon its head.
4. The mosquitoes that carry malaria and yellow fever spend their lives near where they hatch.
5. A town or a country house can be freed of mosquitoes by removing the breeding places.
6. Public health officials are absolutely necessary in fighting mosquitoes.
7. Mosquito larvæ may easily be killed with kerosene.
8. When the mosquitoes in a house are infected with disease germs, they may be killed by burning sulfur in the house.
9. Many towns and communities, some of them very unfavorably located, have freed themselves from mosquitoes.

# CHAPTER TWENTY-FIVE

## SMALLPOX

UP to about a hundred years ago, smallpox was one of the most terrible diseases known to man. It is estimated that in the eighteenth century it killed 60,000,000 people, and that 6,000,000 of the 12,000,000 inhabitants of Mexico died from it when it was introduced into that country by the Spaniards. In Europe nearly every one sooner or later had to undergo an attack of the disease. "It was always present, filling the churchyards with corpses, tormenting with constant fears all it had not yet stricken, leaving on those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, and making the eyes and cheeks of the betrothed maiden objects of horror to the lover." Fortunately for us, a method of preventing smallpox has been discovered, and in civilized countries it has now become a rare disease.

**The germ of smallpox**. Smallpox is caused by a small germ that lives in the skin and in the lining of the mouth, throat, and nose, and sometimes in the trachea and esophagus (page 194). The germs cause pustules or sores to form in the deeper layers of the skin. These break through to the surface of the skin, and in the later stages of the disease the matter from these pustules dries as scabs over the body. The incubation period of smallpox is from seven to twenty-one days.

Some races of smallpox germs are weak and produce a type of the disease so mild that it is often mistaken for chicken pox. Other races are very virulent and cause smallpox of so malignant a type that numbers of the victims die, and many of those who recover lose their

sight. In this disease, as in diphtheria and other infectious diseases, it would seem that weak races of germs may become strong, and that a mild type of the disease may at any time change to the malignant form. It is important, therefore, that mild cases of smallpox should be quarantined and not pronounced chicken pox; for from a mild case of the disease, germs may be spread abroad that will become virulent and bring many persons to their graves.

FIG. 82. By vaccination, smallpox, the disease formerly most dreaded in armies, is now entirely prevented among soldiers.

**How smallpox germs are spread.** The germs of smallpox are abundant in the matter on the skin of a smallpox patient, they are in the discharges from the mouth and nose, and are found in great numbers in the scales that come from the skin during recovery from the disease. These germs may be scattered about by the patient's coughing or sneezing, they are left on anything he touches, they may be carried on the feet of flies, and it is possible that they are at times blown for short distances through the air in the light, dry scales that come from the skin. Smallpox germs may be dried for months without being killed, and on clothing, books, letters, old rags, and many other things, they are sometimes carried about.

VACCINATION

To very few human beings has nature given white corpuscles and germicidal substances that can resist the smallpox germ. Up to the time vaccination began to be practised, more than 95 per cent of all persons suffered from it, and people considered it a disease that every one must have, just as we look on chicken pox and mumps as diseases that most of us will probably have to go through with sooner or later. About the year 1800 vaccination began to be practised, and smallpox at once began to decline. Now vaccination is more or less compulsory in every civilized country in the world. Where it is thoroughly carried out, smallpox has almost ceased to exist, but where the people are not vaccinated, or a considerable number of them are not vaccinated, it is still impossible to prevent the spread of the disease. This is because mild cases escape quarantine, because the germ withstands drying for a considerable period of time, and because it is so powerful a germ that if 100 unvaccinated persons are exposed to it, from 95 to 98 of them will be attacked by the disease.

FIG. 83. Edward Jenner, who in 1797 discovered vaccination, the greatest medical discovery the world has ever known.

**Vaccination an almost perfect protection against smallpox.** In April, 1912, nine cases of smallpox were

reported in Niagara Falls, New York. There had been much opposition to vaccination among the people of this part of New York State, and little vaccination had been performed for twenty years. When the smallpox epidemic started, the local health officer was inactive, and the disease spread until in November, 1913, there were 66 cases, and in January, 1914, there were 204 cases. Effective measures were then taken for the control of the epidemic, and by March 6 more than 25,000 persons had been vaccinated and the cases were put under strict quarantine. In February there were 121 cases, in March 10, in April 2, in May 1, and in the next five months none. Of the 550 cases reported during the epidemic, only 8 had been vaccinated within five years.

FIG. 84. Dr. Benjamin Waterhouse, who introduced vaccination into America in 1800. He insisted on the use of pure virus and keeping the wound clean.

From time to time certain persons in England have opposed vaccination, and for a while the center of this opposition was in Gloucester. In 1895 that city had a population of 42,000, among whom were a very considerable number of persons who had not been vaccinated. In the last weeks of 1895 smallpox broke out, and a great epidemic of 1979 cases and 439 deaths occurred. An attempt was made to control the disease by quarantining and careful disinfection, but this was an entire failure. In January, 1896, there were 28 cases, in February 146 cases, in March 644 cases,

and in April 744 cases. By the end of April more than 36,000 of the inhabitants had been vaccinated, and Gloucester was the best vaccinated city in the world. The epidemic at once began to decline, and by August it had disappeared.

In Philadelphia there was a considerable epidemic of smallpox during the years 1901–1904. During this period more than 3500 cases were admitted to the Municipal Hospital, and of these 3500 cases not one had been successfully vaccinated within five years. During this time many physicians and nurses were employed in the hospital, and more than 700 medical students were taken to visit the patients. Not one of all these persons contracted smallpox except one student who was opposed to vaccination and untruthfully said that he had been vaccinated. At one time it was necessary to enlarge the hospital, and fifty or sixty workmen were employed to do this. All of them were vaccinated except two, and these two and no others took the disease. Again it was necessary to enlarge the hospital, and another squad of workmen was employed. For some reason two of these were not vaccinated. These two were attacked by smallpox, while again all the workmen who had been vacci-

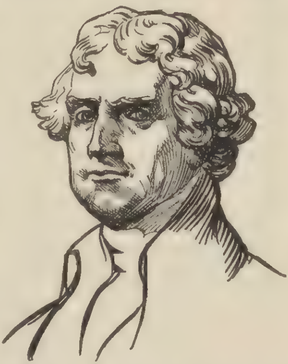


FIG. 85. Thomas Jefferson, one of the most broad-minded and far-seeing Americans of his time. In 1806, writing to Edward Jenner, he said, "Future nations will know by history only that the loathsome smallpox has existed and by you has been extirpated."

nated escaped. Thus within the hospital all of the hundreds of persons who had been vaccinated escaped the disease, and all five of those who had not been vaccinated contracted it.

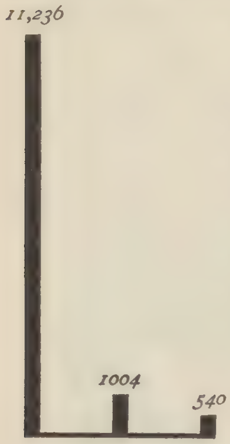



FIG. 86. Diagram showing how vaccination protects against smallpox. During 1912, 1913, and 1914, health officials in the United States secured the vaccination histories of 12,880 smallpox patients. Of these, 11,236 (more than 87 per cent) had never been successfully vaccinated; 1104 (slightly more than 8 per cent) had been vaccinated more than 7 years before the attack; and only 540 (a little over 4 per cent) had been vaccinated within the last 7 years before the attack. (Data from United States *Public Health Report* of October 2, 1914.)

Many pages could be filled with similar statistics showing that vaccination almost surely prevents smallpox. Yet many persons seem never to have heard of these facts, for there are still in our country societies that actively oppose vaccination. Some people think that among those who do not believe in vaccination are some of the prominent physicians of the country. This is a great error, for hardly any of the physicians who oppose vaccination are even graduates of medical colleges, and none of them have any prominence in their profession. The leaders of medicine for the last hundred years have believed in vaccination and have practised it, and today there is not a prominent medical man in America who is opposed to it. On this point the Medical Society of the State of Pennsylvania says: "We know of *no physician of eminence in this country* who is not a believer in — nay, even an ardent advocate of — vaccination."

**How vaccination protects against smallpox.** The germ of smallpox flourishes in man. It grows in cattle also, causing the disease called *cowpox*. After growing in the cow, this germ seems to be weakened and changed so that it grows feebly in man and has only a slight power of producing disease.

In vaccination, germs from a cow are put into the human body. Here they grow and begin to produce the mild inflammation that follows vaccination. The body now works up the germicidal substance for these germs, and because the germs are weak, the body is able to kill them out before they can multiply to any extent. After this is done, the germicidal substance remains in the blood, and if smallpox germs at any time get into the body, the germicidal substance is there ready to kill them and keep the disease from getting a start. A person who has been successfully vaccinated is therefore in much the same condition as a person who has had a light attack of smallpox, for he has in his blood a substance that will kill any smallpox germs that may get into his body.

**How long vaccination protects against smallpox.** After vaccination, the germicidal substance in the blood becomes weaker and weaker, but seldom disappears entirely. Just when it becomes so weak that it is necessary to be vaccinated again, it is impossible to say. Sometimes it is fairly strong after seven, eight, nine, or ten years. In a very few persons it disappears so rapidly that in nine months it fails to protect against smallpox. The safest way is to be vaccinated every few years, and when there is danger of being exposed to smallpox, to be vaccinated again if more than nine months have

passed since the last vaccination. There can be no mistake in this, for if the germicidal substance is still strong in the blood, all the germs put in by vaccination will be killed and the vaccination will not take. If the vaccination does take, it is a sure sign that the germicidal power of the body is beginning to run low and that another vaccination is needed.

**Why every one should be vaccinated.** *Every one should be vaccinated to protect himself.* We never know when the smallpox germ may come to us from the seats of a car, from a letter, from the clothes of some person, or in any one of many other ways. If smallpox germs do get to a person who has been successfully vaccinated, that person will in all probability kill the germs and suffer no harm. If he has not been vaccinated, he will probably suffer from an attack of smallpox, with a considerable risk of losing his life. Even if he recovers, he will be fortunate if he is not more or less scarred and pitted for life.

*Every one should be vaccinated to protect others.* Persons who have smallpox cause expensive quarantine, they interfere with business and with schools, and by scattering abroad smallpox germs they endanger the lives of others. A person who refuses or neglects to be vaccinated and then takes smallpox, makes a public nuisance of himself, and it is neither fair nor right to be a nuisance to one's friends and neighbors. In 1885 *one* man carried smallpox to Montreal and started an epidemic that cost over three thousand lives.

**Little danger in vaccination.** Vaccination causes only a small sore, and there is practically no danger from it when it is properly done. How little danger there really is from it is shown by the fact that 3,709,187

persons were vaccinated by government officials in the Philippine Islands, during the years 1907–1908, without a single death. The greatly swollen arms and running sores that sometimes follow vaccination are caused by pus-forming bacteria and are not a true part of vaccina-


FIG. 87. In the Philippine Islands, before the American occupation, only a small part of the inhabitants were vaccinated. In 1897, about 40,000 people died from smallpox. In 1907, there were 304 deaths from this disease in all the islands. It is vaccination that has caused this decrease, for in most parts of the Philippines there is no quarantine or disinfection of a kind that would have any effect in controlling smallpox.

tion at all. The pus-forming germs usually get into the wound in impure virus, from infected instruments (as from a lancet that has been used in opening a boil), from an unclean skin, or from dirt that gets into the wound. Only pure virus should be used,[1] the skin and instruments should be clean, and the wound (like any other wound) should be protected from pus-forming and tetanus germs.

[1] Only virus that has been carefully prepared and sealed in glass tubes should be used.

When one gets a great sore on the arm, it is not possible to tell whether the vaccination virus is working or not, and many persons who think they have been successfully vaccinated have only had a growth of pus-forming bacteria in their arms.

**A point about germ diseases that should be understood.** It is a common idea that if the blood is "pure" we shall be protected from germ diseases, and if the blood is "impure" we shall suffer from these diseases. This idea is not correct. A person's blood may be as pure as any flowing in the veins of man, and yet that person will fall a victim to smallpox germs if he lacks in his blood the substance that kills those germs. His muscles may be like bands of steel and his nerves may be tingling with the joy and vigor of perfect health, and yet if in his blood there is not the particular substance that kills the tubercle bacillus, he had best beware of that germ. He may even, as we have already pointed out (page 13), have substances in his blood that will enable him to kill some kinds of germs and yet may fall an easy victim to germs of another kind. Resistance to germs is, therefore, not a question of pure blood, but a question of having in the blood particular substances that will kill particular germs.

In former chapters we have advised you to keep up the health of the body so that it will be able to kill germs, and it is true as a general statement that when the body is in health it is able to manufacture more of the substances that kill germs than it can manufacture when it is weak. You should know, however, that for reasons that are not understood, the body sometimes suddenly loses its power to resist germs even when it seems to be

in health. You should also understand that before smallpox germs nearly every one goes down as the wheat goes down before the sickle, and that the only way you can make yourself safe from this disease is to get your body, beforehand, to work up a supply of the germicidal substance for the smallpox germ. Therefore, when any one begins to tell you that health consists in keeping the blood pure, and that vaccination is contrary to the principles of health because it introduces into the body matter from a cow that will cause the blood to be impure — when any one talks to you after this fashion, pay no attention at all to him. For though your blood were as pure as the crystal water from a snow-capped mountain peak, it would not kill the smallpox germ unless it contained the germicidal substance for that germ. It is strong blood, and not pure blood, that we need in our battle with the germs.

### POINTS TO BE REMEMBERED

1. Until vaccination was discovered, smallpox was the most dreaded of all diseases.
2. The smallpox germ can withstand drying and is easily spread.
3. Vaccination almost surely protects against smallpox.
4. In vaccination a weak race of smallpox germs from cattle is put into the body.
5. The body produces a substance to kill these germs.
6. This germicidal substance then remains in the blood.
7. Any danger there may be in vaccination comes from bacteria that get into the wound and not from the vaccination itself.
8. It is best to be revaccinated every few years, and whenever one has been exposed to smallpox.
9. Pure blood may not protect us from germs.

# CHAPTER TWENTY-SIX

## OTHER PROTOZOAN DISEASES

In the tropics there are many protozoan diseases that are unknown in our country. Among these diseases is the slow and surely fatal *sleeping sickness* of Africa, which is estimated to have killed a half million people between the years 1896 and 1906. It is communicated to man by the bite of a fly, and in some villages from 30 to 50 per cent of the people are affected.

Another protozoan disease of hot countries (a severe malaria-like fever called *kala-azar*) is carried by the bedbug and probably also by the flea. Chronic dysentery is another very important protozoan disease, and there are a number of other diseases that are probably caused by protozoa, although the germs that cause them are unknown. In this chapter we shall study certain of these diseases that are of importance in the United States.

### RABIES (HYDROPHOBIA)

Rabies is caused by a very small germ that is believed to be a protozoön. It grows especially in the brain and spinal cord and gets into the body usually from the bites of dogs or cats. In man the incubation period is never shorter than fourteen days; usually it is five or six weeks, and it may be a year. The germs are in the saliva three days (possibly eight days) before the animal shows symptoms of the disease. In their wild state, wolves, foxes, coyotes, and skunks may suffer from the disease.

**Preventing rabies.** Practically all the rabies in our country comes from the bites of dogs, and by keep-

ing dogs properly muzzled it is possible to stamp out the disease entirely, as has been done in several European countries.[1] It is a mistake to think that rabies develops in dogs because of hot weather or lack of water. The dog gets the germ into its body from the bite of another dog, and dogs may suffer from the disease at any time of the year. A rabid animal has a habit of scratching at its mouth to remove the tough saliva, and a wound from the claws of such an animal is therefore dangerous.

FIG. 88. If all the dogs in our country could be muzzled for a few years, rabies would disappear. The dogs could then be unmuzzled without danger of the disease to man or beast.

**The Pasteur treatment.** There is no cure for rabies after the disease develops, but a preventive treatment has been discovered by a great Frenchman named

[1] The following statistics give the number of deaths from rabies in England and Wales for each year, from 1887 to 1907, and show clearly how muzzling dogs checks the spread of the disease: —

| *Year* | *Deaths* |
| --- | --- |
| 1887 | 29 |
| 1888 | 14 |
| 1889 | 30 |
| *Muzzling enforced* | |
| 1890 | 8 |
| 1891 | 7 |
| 1892 | 6 |
| *Opposition to muzzling; ordinance not enforced* | |
| 1893 | 4 |
| 1894 | 13 |
| 1895 | 20 |

*Muzzling again enforced*

| *Year* | *Deaths* |
| --- | --- |
| 1896 | 8 |
| 1897 | 6 |
| 1898 | 2 |
| 1899 | 0 |
| 1900 | 0 |
| 1901 | 0 |
| 1902 | 2 |
| 1903 | 0 |
| 1904 | 0 |
| 1905 | 0 |
| 1906 | 0 |
| 1907 | 0 |

Louis Pasteur. This treatment is founded on the same principles as vaccination. Weak germs are put into the body, and by killing these weak germs the germicidal power of the body is increased. The body then goes on and not only kills the weak germs that have been put into it during the treatment, but kills also the germs that are in the wound made by the rabid animal. Thus the disease is prevented. The Pasteur treatment is successful in nearly all cases in which it can be commenced in time. Where the materials for this treatment can be delivered within thirty-six hours after they are shipped, they can be sent by mail and the treatment can be given to the patient by his home physician.[1]

**Treatment of wounds made by rabid animals.** A very great safeguard against rabies is to treat promptly all wounds made by the teeth of animals with something that will kill the germs in the wound. Any disinfectant (page 159) is useful, but burning with nitric acid is the most effective remedy. This should be done by a physician, to make sure that it is thoroughly done, and to guard against too great injury to the flesh by the acid. The best way is to wash the wound at once with

[1] There was formerly a curious superstition that certain stones, called "madstones," would prevent rabies. Some person in the community would possess one of these stones, and when any one was bitten by a rabid dog, the stone would be applied to the wound to "draw out the poison." It need hardly be said that madstones are of no use in preventing rabies, and that intelligent persons long ago gave up their use. It is perhaps well to know that in several instances rabies is believed to have been caused by the use of a madstone. The stone became infected with the germs from the blood and saliva in wounds to which it had been applied, and then, when placed on a wound made by a dog that did not have rabies, the germs were introduced into the wound and the disease was produced.

turpentine, carbolic acid, bichlorid of mercury, or some other disinfectant, and then go to a physician. Treatment even after twenty-four hours is useful. It is easier for the body to kill a few germs than a large number, and a disinfection of the wound that kills even a part of the germs is a great help. An animal that has bitten any one should not be killed, but should be shut up until it is known whether or not it has rabies. If the animal remains in health for nine or ten days, there will be no occasion for worry. If it shows symptoms of the disease, it should be killed without injuring the brain, and the head should be sent to a Pasteur Institute or to a bacteriological laboratory. There the brain can be examined for the germs of rabies, and if they are found, it will be certainly known that the treatment should be begun at once.

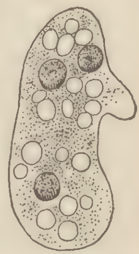


FIG. 89. The germ of dysentery. The dark bodies in the germ are red blood corpuscles on which the germ feeds.

CHRONIC DYSENTERY

Acute dysentery (page 81) is caused by a bacillus that is closely related to the typhoid germ. There is a chronic form of dysentery, however, that is caused by a protozoön. This germ is much larger than most disease germs, and in many ways it resembles a large white blood corpuscle. Its life outside the body is not well known, but there is abundant evidence that the disease is usually contracted by drinking impure water. Infection seems to come also, at times, from eating raw vegetables that have been grown in polluted soil. Chronic dysentery is

more common in the southern than in the northern states, but cases of it occur in all parts of the country.[1]

### MEASLES

Measles is a very infectious disease even in the early stages. The breaking out is not only on the skin but also in the eyes, throat, and air passages, and the germs are in the secretions from these parts. During an attack of measles the eyes should be rested, shaded from light, and bathed in boracic acid or other disinfectant several times a day, and the patient should have careful nursing and be protected from the germs of colds, influenza, pneumonia, and tuberculosis; for, more than almost any other disease, measles weakens the resistance of the body to all germs, and many cases of bronchitis, pneumonia, and consumption follow an attack of this disease. The incubation period is very regularly from nine to eleven days, and the eruption usually appears the fourteenth day. This disease is much more dangerous to children than to older persons, and the great majority of deaths from measles is among children under five years of age.

Measles is a far more serious disease than is generally supposed, and it should be strictly quarantined (page 207). A patient is dangerous as long as the discharges from the eyes and nose continue, usually for a period of about three weeks from the breaking out of the rash. In a house the germs die out in about two weeks. German

[1] Dysentery germs are abundant in the discharges from the bowels of any one who is sick with the disease. It is therefore very important that these discharges should be carefully destroyed (page 161), so that the germs may not be carried about by flies or in other ways.

measles is supposed to be a different disease from ordinary measles, and one that is less severe.

### CHICKEN POX

Chicken pox is usually a mild disease and seldom attacks any one but children. It is of importance mainly because mild cases of smallpox are often mistaken for it. The incubation period is from thirteen to eighteen or nineteen days.

### SCARLET FEVER

The germ of scarlet fever has not been discovered, but it is known that the discharges from the throat, nose, eyes, and ears are infectious, and the patient is dangerous as long as these discharges continue. The germs withstand considerable drying, but the scales from the skin are not infectious and the disease is not air-borne, as was formerly supposed. It is a difficult disease to control, because there are mild cases ("missed cases") of it that are not recognized and quarantined. The incubation period is from two to five days, and the patient is usually quarantined about fifty days. It attacks children especially, and a person usually has the disease but once.

Scarlet fever is a very dangerous disease because there often goes with it a severe attack of the pus-forming bacteria on the kidneys, ears, eyes, throat, or other part of the body, and it is not uncommon for it to leave its victims deaf or blind, or in some way injured for life. It should, therefore, be carefully quarantined, and a close watch kept for the mild cases from which epidemics often spring (see footnote, page 205).

### PROTOZOAN DISEASES OF ANIMALS

Texas fever, or "tick fever," a very severe malaria-like disease of cattle in the southern part of the United States, is due to a protozoön in the blood. This germ is carried from one animal to another by a kind of tick. Nagana is an African disease of animals, the germ of which is carried by a fly. This disease kills all horses and cattle over a large area in central Africa, and makes travel and agriculture very difficult in that region. Surra is a protozoan disease spread by the bites of flies that is fatal to great numbers of horses and cattle in India and other parts of southern Asia, in the East Indies, and in the Philippines. Protozoa are found also in the blood of rats; and birds, turtles, frogs, and many other animals are infected with them.

### POINTS TO BE REMEMBERED

1. Rabies is due to a very small germ that attacks especially the brain and the spinal cord.
2. Almost all the rabies in our country comes from dogs, and the disease can be stamped out by properly muzzling dogs.
3. The Pasteur treatment will usually prevent rabies from developing, if treatment is begun in time.
4. A wound made by the teeth of an animal should be carefully disinfected.
5. Chronic dysentery is a protozoan disease and usually is contracted from polluted water.
6. Measles and scarlet fever are dangerous diseases that should be strictly quarantined.
7. Many diseases of animals are caused by protozoa.

# CHAPTER TWENTY-SEVEN

## INTESTINAL WORMS

Intestinal worms are in no sense germs, for their bodies are composed of many cells, and some of them are animals of considerable size. Yet we shall briefly discuss some of the more important of them, because they afflict more people than is generally known, and because by proper sanitation they can be avoided. How important this subject is may be known when it is learned that in some tropical countries almost the whole population is infected with these worms, and that in some temperate countries examinations have frequently shown that from 30 to 50 per cent of the people of a community were infected with intestinal worms of one kind or another. Extensive studies of this subject made in the United States show that intestinal worms are much more frequent in the southern states and in California than they are in the northern states.

### EELWORMS

Eelworms (*Ascaris lumbricoides*) are large, yellowish white worms, thicker than a lead pencil, and sometimes over a foot long. Many persons, especially children, suffer from them. The eggs are swallowed and hatch in the intestine. The young worms then make their way to the lungs, pass up the trachea to the throat, and reach the intestine again by being swallowed. There is evidence that the young worms damage the lungs and bring on attacks of pneumonia, and the adult worms cause nervousness and weakness. Several kinds of domestic animals as well as man are attacked by these worms, and the eggs are in the intestinal wastes of infected animals and persons.

### PINWORMS

The pinworm (*Oxyuris*) is a small white worm that grows mainly in the lower part of the large intestine. The disease is most common in children. The eggs are often on the hands of infected children; they may get into drinking water; or children, by playing in polluted soil, may get the eggs on the hands and into the mouth. Children that are infected should be treated, so that they may not infect others, and the soil about wells and houses should be kept free from pollution.

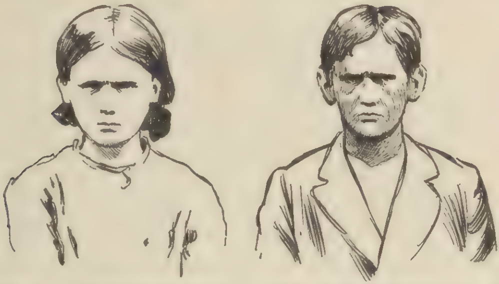
### WHIPWORMS

The whipworm (*Trichuris*) is a slender white worm nearly two inches in length. The eggs get into the body by being swallowed. In some parts of Europe from 10 to 30 per cent of the people are infected, and it is known that the disease is not at all uncommon in the United States.

### HOOKWORMS

The hookworm (*Necator*) is white in color, of the thickness of a moderate sized sewing thread, and about one third of an inch in length. This worm is found in the warmer parts of the whole earth, Africa, India, China, Porto Rico, Guiana, Colombia, the Philippines, and many other places being heavily infected. Of more than 700,000 persons examined for hookworm in the southern part of the United States, 35 per cent were found to be infected, and it is estimated that there are two million people in this region suffering from the disease. The worms live in the small intestine and feed on blood which they suck from the wall. Much blood

besides that which they use for food is lost through the wounds that they make; for they move about freely in the intestine and keep making fresh wounds in the wall. A person may carry any number of them from a very



FIGS. 90 and 91. Hookworm victims. (*After photographs by Dr. Charles W. Stiles, U. S. Public Health and Marine-Hospital Service.*)

few up to several thousands, and severe cases of the disease may end in death.

**How hookworms get into the body**. The eggs of hookworms pass out of the alimentary canal, and if they are allowed to get into the soil, they develop into very tiny worms. These small worms usually enter the body through the skin (causing "ground itch," "toe itch," or "dew sores"), make their way to the lungs, crawl up the trachea to the mouth, and reach the intestine by being swallowed. They may also be taken into the intestine in water, or in food that is eaten with soiled hands. The worms do not multiply in the intestine, but they are known to live for more than six years and they probably live as long as ten years. Under favorable conditions, the young have been found to live in the soil for more than five months, but both the eggs and the young worms are killed by thorough drying and by freezing.

**Hookworm disease.** The hookworm produces a toxin which poisons the body, and this with the loss of blood causes a marked anemia (lack of red blood corpuscles). Some of the prominent symptoms of the disease, which are especially marked in severe cases, are paleness, continued weakness, mental dullness, dry skin and hair, dull, staring eyes, swelling of the limbs and face, and in young persons a stunting of the growth. Sometimes there is an appetite for such substances as earth, ashes, paper, coffee grounds, salt, and plaster.

**Where hookworm disease is most common.** Hookworm disease is most common on light and sandy soils (the kind of soil on which pine trees grow). It is more common among children than among adults, because children go barefooted, and sometimes eat with unwashed hands after playing in the earth; it is more common among miners, agricultural laborers, brickmakers, and railroad laborers than among those who do not come in contact with the soil; and the disease is more severe (though not more common) in the white than in the colored race.

**The prevention of hookworm disease.** The eggs of hookworms get into the soil only from persons who have the disease. Away from the air, or in very wet soils, the eggs die, and *the disease can be entirely prevented by the use of closets.*[1] Great care should therefore be taken to prevent the pollution of soils about houses. To a great extent children may be saved from infection by the wearing of shoes; but keeping the soil free from

[1] Of 189,586 country homes inspected by the Rockefeller Sanitary Commission, 95,988 had no closets at all, and 87,156 others had open closets that allowed the wastes to spread freely over the soil.

pollution is the important measure in the prevention of hookworm disease (page 203).

**Weakness caused by intestinal worms.** Hookworm victims are too weak to work effectively, and hundreds of thousands of persons are living in poverty and ignorance because of this disease. Because these persons do not have the symptoms of ordinary sickness, it is often not realized that they are in a diseased condition, and their poverty is attributed to shiftlessness and laziness instead of to the true cause.

The sapping of the vitality of the body by these small robbers also lessens the resistance of the body to tuberculosis and other germ diseases. An instance of the truth of this statement comes from the Philippine Islands. When American officials took over from the Spaniards the great prison in Manila, there were about 4000 prisoners in it. Most of these prisoners seemed to be in fairly good health, but many of them died of diseases from which they should have recovered, and in spite of all the care of the authorities, the death rate was very high (about 70 a year for each 1000 prisoners). An examination with the microscope showed nearly all the prisoners to be infected with intestinal worms. Medicines were then given to kill the worms, and after that the death rate in the prison was little more than one sixth of what it had been before (falling to 12 a year for each 1000 prisoners). These facts show clearly that intestinal worms lower the resistance of the body to disease germs.

**Preventing the spread of intestinal worms.** The first great step in preventing the spread of intestinal worms is *to treat the persons who are infected with medicines to*

*kill the worms.* This will not only restore these persons to health, but it will stop the supply of eggs that infect others. Hookworm disease is especially easy to cure; for a few doses of a very simple remedy will entirely free a patient from the worms.

The second great step in the prevention of the spread of intestinal worms is *to build closets to receive the wastes from the alimentary canal, and to stop the pollution of the soil about houses and school grounds.* This precaution alone will not only almost entirely prevent the diseases that are caused by intestinal worms, but it will in a great measure prevent the spread of intestinal diseases that are caused by germs. It is to be remembered that many persons who themselves show no signs of ill-health may be infected with intestinal worms, and *all* soil pollution about houses should be stopped.

### POINTS TO BE REMEMBERED

1. Intestinal worms are far more common than has been generally supposed.
2. The young of the eelworm develop in the soil and are swallowed in water.
3. Pinworms may be spread by the hands or by water.
4. Whipworms are swallowed in water.
5. Hookworm infection is common in our southern states.
6. The young worms get into the body either by passing through the skin or by being swallowed.
7. This disease causes much poverty and ignorance.
8. Hookworm victims fall an easy prey to other diseases.
9. The disease can be prevented by preventing soil pollution.

# CHAPTER TWENTY-EIGHT

## THE IMPORTANCE OF SANITATION

SUPPOSE that on a certain day in every year all the people in a village of a thousand inhabitants had to march past a bag in which there were a thousand balls, and each person had to draw a ball from the bag. Suppose that in the bag there were as many white balls as there were persons in the village who would escape all germ diseases during the next year, and as many balls of various colors as there were persons in the village who during the next year would be attacked by germ diseases. Suppose also that as many of these colored balls were marked with black crosses as there were persons in the village who in the next year would die of diseases caused by germs. In an average American village, then, there would be in the bag two or three red balls for those who were marked for tuberculosis, the same number of green balls for the victims of typhoid, perhaps eight or ten blue balls for those selected for pneumonia, and a great number of other balls of various colors for those who must suffer from some serious infectious disease, such as diphtheria, meningitis, influenza, whooping cough, measles, or scarlet fever. There would also be in the bag some six or eight balls marked with the fatal black cross, which meant that before the year was done whoever drew that ball would die because of germs.

If all the people of a town had to go through a drawing like that described above, would there not be a great fear in the heart of every one lest he or some one whom he loved should draw a fatal ball? And if some one should come to the village who could show the people what to do so that there would be only a few colored

balls and almost no balls with black crosses in the bag, would not the people help him and encourage him in every way? We are sure that they would gladly give him the money that he needed in his work, and that they would assist him as much as was in their power.

FIG. 92. Louis Pasteur. He discovered the Pasteur treatment for rabies and did more than any other one man to make clear to us the nature of germ diseases and to point out ways by which these diseases can be prevented.

**The danger from germ diseases in the average American town.** In the average American town the people are in the same danger from germ diseases that they would be in if they had to go through a drawing of lots like the one described above. This you can readily believe after your study of former chapters of this book. In every town a certain number of people are stricken with infectious diseases each year. Each year we hope that neither we ourselves nor any one who is dear to us will be the victims of the germs, but who they will be it is never possible to tell. Victims there will certainly be, for neither by day nor by night do our small enemies rest, and year by year they take their toll from every village in the land.

**Our defenders from the germs.** From the beginnings of history, man has been attacked by unseen foes, slain by hands that were invisible. In the last thirty years our enemies have been found out, their homes have been

discovered, their ambuscades have been torn down, and the paths by which they reach us have been traced out. We have now physicians and health officers who can tell us how to escape most of the germs that attack us. They have come to show us "how to arrange matters so that there will be very few colored balls and almost no balls with black crosses in the bag." Shall we work with these persons who can in great measure defend us from the germs that would attack us, or shall we refuse their aid and allow the germs to ravage and destroy, as they have done ever since man has lived upon the earth? This is the question that each community is now being asked to decide.

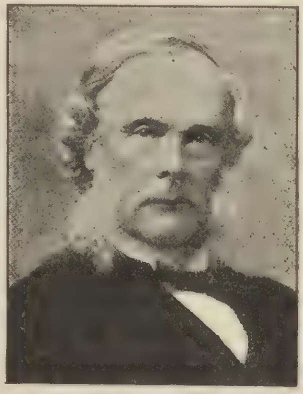


FIG. 93. Lord Lister, an English physician, who showed how to keep wounds free from infection and thus made modern surgery possible.

**Sanitation.** Sanitation comes from a Latin word (*sanitas*) that means wholeness, or health. It is the science of how to preserve the health, especially the public health. To have our premises clean and free from flies and mosquitoes, our milk and water supplies pure, and the air we breathe free from dust, is sanitary. To live among insects, dirt, and germs, to drink impure water and unclean milk, and to allow germs to be spread abroad from the bodies of persons who are diseased, is insanitary.

It is of interest to note that from the same Latin word from which *sanitation* comes, we get also our words

*sanity* and *saneness* (soundness of mind), and *insanity* (unsoundness of mind). *Sanity* and *sanitation* mean the same in their origin, and we might conclude that to practise sanitation is to act sanely and sensibly, while not to practise it is to act in a way that indicates either a lack of knowledge or a lack of wisdom. Certainly (since every one is anxious to escape disease) we should not be far from the mark if we spoke of a town that was clean and free from dangerous germs as a sensible, sound-minded town, and of a town in which the people lived amid dirt and germs as a foolish town. In former chapters of this book we have discussed the importance of keeping down dust, of having pure water supplies, and of destroying mosquitoes. We shall now study other measures that may be employed in making our homes and communities sanitary places in which to live.

## POINTS TO BE REMEMBERED

1. Every year in every town a number of persons are attacked by disease germs.
2. Most cases of germ diseases can be prevented.
3. Physicians and health officers can tell us how to escape these diseases.
4. It is sensible to practise sanitation and, as far as possible, avoid germ diseases.

# CHAPTER TWENTY-NINE

## THE HOUSEFLY

THERE is a belief among some people that flies are useful because they feed on wastes. No greater mistake could be made. Flies light on and walk over all manner of unclean matter, and then spread germs and uncleanness over dishes, food, and milk vessels. They may come to our faces straight from feeding on the sputum of a consumptive or the wastes of a typhoid patient. They may fly directly from some one who has sore eyes to our hands or faces or to the very eyes of a little baby that cannot defend itself from them. There is nothing more dangerous or more unclean than to live among a swarm of flies.

**Kinds of germs carried by flies.** Almost any kind of germ may be carried by flies. Not only do they carry germs on their feet, but when a fly feeds on matter that contains disease germs, the germs are found in the matter that comes from its alimentary canal. In one speck left by a fly that had been captured on the face of a leper, 1115 leprosy germs were found. Tuberculosis germs and typhoid germs have also been found in fly specks, and there is no reason why a fly that walks over or feeds on matter containing the germs of any disease should not spread abroad those germs (page 192).[1]

**Keeping germ-containing matter away from flies.** A fly may get germs on its feet by walking on the skin of a patient who has smallpox, measles, scarlet fever, or

[1] A study of 415 flies showed them to be carrying from 550 to 6,600,000 bacteria. The average was 1,250,000. Living typhoid bacilli have been found to remain in or on the bodies of flies for 23 days, and tubercle bacilli for 15 days.

erysipelas. It may easily take up dangerous germs from an open sore or ulcer. Flies are certain to become infected if they are allowed to feed on the sputum of a

FIG. 94. This child is healthy and well, but flies may leave disease germs in his food.

consumptive, pneumonia, influenza, or diphtheria patient. The wastes from typhoid, dysentery, and cholera infantum patients must be absolutely destroyed, or flies may carry the germs all over the vicinity and may endanger

the life of every one in the neighborhood. In general, it is unsafe to have flies about any person sick with an infectious disease, for there is always danger that by lighting on his hands or face, or on some article in the room, they will take up germs.

**Screening against flies.** From what you already know you will realize the importance of screening against flies, of freeing our houses as much as possible from them, and of covering all food and dishes from flies. When any flies at all are in a house, a young child should aways be screened from them, for it is not right to leave a helpless little baby where it will not only be continually annoyed by flies crawling over it, but will have many different kinds of dangerous germs left on its face.

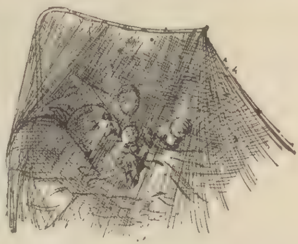


FIG. 95. A baby should be screened from flies.

**Removing the breeding places of flies.** By far the most effective way of dealing with flies is to remove their breeding places. The egg of the housefly is laid in manure (chiefly in horse manure, and almost entirely in fresh manure) about stables, and to some extent in dry closets, garbage, and decaying vegetable matter. In a day or less the egg hatches into a small, white, footless maggot, which in nine or ten days from the time the egg was laid changes into the adult fly.

It is estimated that three hundred flies may hatch in a cubic inch of manure, and if the breeding places of the flies are left undisturbed, they will hatch faster than it is possible to kill them. It is a simple matter, how-

ever, greatly to decrease their numbers by removing daily all matter in which they breed, burying it, or spreading it on the fields where it will dry and the eggs and young of the fly will be killed.[1] They can also be kept from breeding in manure by covering it with lime, or sprinkling it with borax or a solution of hellebore in water.


FIG. 96. The life history of the fly. *A* shows the eggs; *B*, the larva or maggot; *C*, the pupa; and *D*, the adult fly.

A bulletin giving full directions for doing this may be obtained from the United States Department of Agriculture, Washington, D.C. Generally speaking, these measures are more difficult and less effective than removing the manure before the maggots have time to mature.

**Killing adult flies.** It is important to destroy flies that are already hatched; for the same flies may remain about a house all summer unless they are trapped or killed. The giant flytraps, that are now bought or

[1] Floors of stables must be made of cement or other tight material; otherwise the flies will hatch in the crevices and in the earth that becomes soaked with the liquid manure. Usually eggs are laid in manure before it is removed from the stalls, and if it is stored these eggs will hatch unless they are killed by lime or some other substance.

made, fly paper, poisons, and the fly swatter, are all useful in ridding a house of these pests.[1]

**The economy of fighting flies and mosquitoes.** Under ordinary conditions it is not expensive to remove the

FIG. 97. In a manure pile like this, millions of flies will breed.

breeding places of flies and mosquitoes in a town, and no money that a town can spend will pay better, either

[1] The following hints may prove useful in the warfare on flies: Hang screen doors to open outward and rub them with a cloth dipped in kerosene or carbolic acid solution; make tops of traps of wire or glass so that the flies will come up to the light; use bananas or bread and milk for bait; take away water and food, so that the flies will come to traps or materials placed for them; mix finely ground black pepper with hard boiled yolk of egg or add two tablespoonfuls of formalin to a pint of milk and expose to flies. Neither the pepper nor the milk with the formalin in it is poisonous to children or animals. The milk placed on porches where flies gather is particularly effective on hot, dry days.

in dollars and cents or in the comfort that will come to the inhabitants, than money that is spent to free the town from these insects. In a small town one man can easily look out for all breeding places of mosquitoes. This will mean that there will be no malaria in that town; and there are many small towns that would have been large cities long ago if they had been free from malaria. A town cart can remove weekly all the matter in which flies breed, and this matter can be sold for fertilizer for almost enough to pay for the expense of removing it. Boards of trade often try to improve and advertise their towns. Suppose a board of trade could say: "In our town you will not be bothered by mosquitoes, and neither you nor any member of your family will have malaria. You will not be annoyed by flies, and you need not fear that while you are looking the other way a fly will leave typhoid germs on your plate." Would not a board of trade that could truthfully say this about its town have some facts to present that would interest persons who were seeking new homes?

### POINTS TO BE REMEMBERED

1. Flies are very unclean and can carry almost any kind of disease germs.
2. Flies should not be allowed about sick people or about the wastes from the sick.
3. Flies breed in manure and in other waste matter.
4. These breeding places should be removed.
5. Adult flies may be destroyed by traps, fly paper, poisons, and fly swatters.
6. A town that is free from mosquitoes and flies has many advantages over towns that are overrun with them.

# CHAPTER THIRTY

## DISEASE GERMS IN FOOD

Foods (excepting milk) are not so likely as water to contain disease germs, but when foods become infected they are particularly dangerous, because germs can multiply in them. To appreciate this point you must understand that it is far more dangerous to take a large number of disease germs into the body than it would be to take a few germs of the same kind. A few dozen or a few hundred of almost any of the ordinary disease germs have no power to harm a rabbit when they are injected into its body, but if the dose is increased to several million germs, often the rabbit will die. Its white corpuscles and germicidal substances have the power to kill a few germs, just as the soldiers in a fort can drive away a small company of besiegers who are trying to break down the front gate of the fort. But when millions of germs attack the body at once, the defenders of the body cannot overcome them, just as the defenders of the fort would be unable to resist successfully a great multitude of attackers, who would not only try to enter through the front gate, but at the same time would break down all the other gates and swarm over the walls at every point. It is because in many foods a single germ can increase to a multitude that our foods especially need to be guarded against infection.

**How germs get into foods.** Not only the germs of intestinal diseases, but also the germs of such diseases as tuberculosis, pneumonia, diphtheria, and scarlet fever, may reach the mouth in food. These germs get into the food from polluted soil, from flies, from washing in impure water the food or the vessels in which food is

kept, from diseased animals, and most commonly of all from the hands of those who are carrying germs.

FIG. 98. Food that has been handled by the public is likely to contain germs.

Those who prepare food should pay special attention to the cleanliness of their hands, washing them often with soap and water (page 161), and no one who is sick with an infectious disease or who is just recovering from such a disease, should have anything to do with the handling or the preparation of foods.

**Danger from spoiled food**. Besides the germs of special diseases, there are always present in foods the bacteria that cause fermentation and decay.[1] These bacteria do not ordinarily cause sickness in man, but when taken into the alimentary canal in the prodigious numbers in which they are found in foods that are beginning to

[1] If foods are cooked sufficiently to kill all bacteria in them (spores as well as the growing forms of the bacteria), and then sealed away from germs, as is done in cans, they may be preserved for years without decay. Strong salt solutions (brine) will also preserve foods, and strong sugar solutions, such as are used in preserving, will prevent the growth of germs in food.

spoil, they cause fermentation in the intestine, diarrhea, and other troubles. Tainted and soured foods are therefore unsafe and should never be eaten.

**Buying foods.** The wise person buys his food in a store that is kept clean and where the food is protected from dust and flies. He never buys old and tainted meats or fish, or overripe or decaying fruits or vegetables, for these are swarming with bacteria and are already unfit for use. Above all, he will not buy any food that has been fingered over and handled by the public, for there is always danger that on such foods disease germs have been left from the fingers of some sick or germ-carrying person.

**The care of foods.** In the care of foods two points are of especial importance. These points are *cleanliness* to prevent germs from getting into food, and *cold*, to keep germs that do get into the food from multiplying. The importance of cooking to kill any disease germs that may be in foods, as well as to kill certain worms that may be in meats, will of course be understood. It should also be understood that by thorough cooking all bacteria of every kind in food may be killed, and that food may be preserved in this way until a new supply of them has time to grow.

**Dangers from milk.** Of all foods that are used by man, milk is the most dangerous, because without any cooking it furnishes a splendid place for the growth of almost all kinds of germs. Tuberculosis is sometimes contracted from milk, and it is known that typhoid fever, scarlet fever, and diphtheria may be spread by milk. Again and again it has been found that along the route of a certain milkman the people were suffering from

one of these diseases, and on investigation it would be proved that a case of the disease existed among those handling the milk or in their families; or that the bottles had been taken back from families where the disease was; or, in epidemics of typhoid fever, that the milk vessels had been washed in water from wells containing the typhoid germ. One article in a medical journal reported 330 epidemics traceable to milk, of which 195 were typhoid epidemics, 99 were epidemics of scarlet fever, and 36 were diphtheria epidemics. No person who has consumption, or who has recently recovered from typhoid fever or other germ disease, should have anything to do with the milking of cows or the handling of milk. In general, the safest milk is that which is bottled at the dairy where it is produced. If possible, milk should be secured from a dairy that is known to collect and bottle its milk under sanitary conditions. It is difficult for a private citizen to guard against dangers from milk, and in all well-governed cities a health officer looks after the milk supply.

**Milk and cholera infantum.** Most cases of cholera infantum are due to germs that are in milk.[1] Sometimes, as we have already learned (page 84), it does not seem to be any one special germ that is causing this disease, but the enormous number of many different kinds of bacteria that are in the milk in hot weather. Only pure milk is a fit food for babies, and milk that is filled with a multitude of bacteria and their poisonous toxins is unsafe. Especially in the months when babies are weakened by heat is a pure milk supply important.

[1] Of 9111 infants that died during one year in a large European city, only 844 were fed entirely on their mothers' milk.

FIG. 99. Dairies should be models of cleanliness.

**Keeping milk free from germs.** All milk vessels and feeding bottles for babies should be thoroughly scalded before using to kill the bacteria in the milk that adheres to them. Otherwise these bacteria will multiply in the new milk, and soon it will be filled with them (page 18). Milk vessels should never be rinsed in any but boiled water, the purest of rain water, or artesian water, for one dangerous germ that gets into the milk from the water remaining on the vessels may grow into a multitude. Milking should be done in a clean building that has fly screens on it, and everything possible should be done to keep dust and hairs out of the milk, for these are loaded with bacteria. The milk should be cooled as quickly as possible, and kept cool to prevent the germs that do get into it from multiplying. It should

be used before it becomes old, for milk that at first has only a moderate number of bacteria in it may soon be filled with countless myriads of them. It is also necessary for a medical officer to examine the cows from which the milk comes, or there will frequently be living tuberculosis germs in the milk (page 59).

**Killing germs in milk**. When it is impossible to obtain pure milk, it is often best to "Pasteurize" the milk before it is used.[1] This is done by heating it to 145 degrees and holding it at this temperature for thirty minutes. This heating kills all disease germs and nearly all the other bacteria in the milk, and the person who uses the milk has fewer germs to resist. A few children do not digest Pasteurized milk as well as they do raw milk, and Pasteurizing old milk that is already filled with acids and toxins from the bacteria that are swarming in it will not make this milk a fit food for a little child. In summer, however, most of the milk sold in cities is greatly improved by Pasteurization, and it is of no small advantage that all the tuberculosis, typhoid, diphtheria, and other dangerous germs that are in the milk are

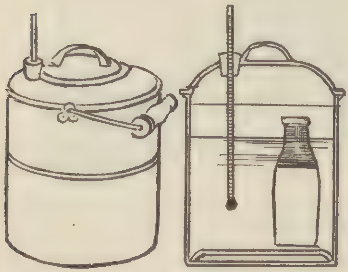


FIG. 100. A vessel arranged for Pasteurizing milk. Very convenient Pasteurizers for use in the home may be purchased at a low price.

[1] Recently many great epidemics of very severe sore throat (*septic sore throat*) have been traced to infected milk. The disease is caused by a streptococcus that causes inflammation in the udder of the cow. Cows probably get the infection from the hands of persons who have the disease.

killed. In fact, so much disease has been found to be due to milk that many health officers believe that all milk should be Pasteurized before it is put on the market, and that the sale of raw milk should be forbidden.

It should be understood that although disease germs in milk are killed by Pasteurizing it, certain hardy kinds of bacteria and many bacterial spores are not killed by the process. After milk is Pasteurized, it should be cooled at once, or these surviving forms will quickly multiply and cause it to spoil.

### POINTS TO BE REMEMBERED

1. Infected foods are particularly dangerous because disease germs can multiply in food.
2. Germs can get into foods from flies, impure water, and from the hands of persons who are carrying germs.
3. Spoiled foods are unfit for use.
4. Foods that have been handled by the public, or exposed to flies, should not be purchased.
5. Cleanliness and cold are the points to be emphasized in caring for foods.
6. Impure and unclean milk is the most dangerous of all foods; tuberculosis, typhoid fever, scarlet fever, and diphtheria may be contracted from it.
7. Cholera infantum is usually caused by unclean or old milk.
8. Milk vessels should be carefully scalded and should be rinsed only in pure water.
9. Milk should be collected in as cleanly a manner as possible and cooled quickly to prevent the multiplication of germs in it.
10. When milk contains many bacteria, it is usually advisable to Pasteurize it before giving it to a little child.
11. Many health officers believe that all milk should be Pasteurized before it is sold or used.

# CHAPTER THIRTY-ONE

## DISINFECTION

It cannot be too strongly emphasized that nearly all the germs that cause disease in man come from persons who have germ diseases, and that insects, water, and food are dangerous only when they have become infected with germs from some human being. In preventing the spread of infectious diseases, therefore, the most important point is to destroy the germs that come from the bodies of the sick.

**Light**. Light is destructive to bacteria, and bright sunlight kills many kinds of germs in a few minutes. It is an excellent practice to expose bedclothes and rugs to the sun, and to throw up the shades and allow the sunlight to enter the house. In rooms occupied by consumptives or by pneumonia, diphtheria, or influenza patients, this is especially important.

**Drying**. Drying checks the growth of all germs, and most germs die if they are thoroughly dried. Damp houses keep alive the germs that are in them, and consumption, pneumonia, and other diseases are more likely to develop in damp than in dry houses. Dirt and dust, mingled with sweat and oil from the skin, on doorknobs, banisters, and furniture, protect germs from light and keep them alive. For this reason the doorknobs and desks in schoolrooms should be cleansed occasionally with soap and hot water.

**Heat**. Boiling water kills the germs of all common diseases, and handkerchiefs, dishes, and clothing that have become infected can be made safe again by thoroughly boiling them. Sputum and articles of little value may often be most conveniently disposed of by

burning (page 56). The surfaces of dishes contain tiny crevices in which germs lodge, and in disinfecting dishes with hot water, it is necessary to leave them for a few minutes in water that is boiling, so that the heat will reach the germs in the crevices.

**Chemical disinfection.** Certain chemicals are so poisonous to germs that they are extensively used in disinfecting. A physician should always be consulted as to which disinfectant is best for a particular purpose, and exactly how to use it, for some of them are better for one purpose than for another. Most disinfectants are very poisonous, and a little red ink or other coloring matter should be added to them so that they will not be mistaken for water. The following are some of the most common disinfectants: —

*Bichlorid of mercury* (corrosive sublimate) dissolved in water, with one part of the bichlorid to a thousand parts of water (1 ounce to 8 gallons of water), kills nearly all kinds of germs in two or three minutes. This disinfectant can be purchased in tablets of the right size to make a pint or half a pint of the solution. For the hands, for washing floors and furniture, and for disinfecting clothing that can be soaked in it, this is an excellent disinfectant. It cannot be used on metals, as it destroys them, and it is not good for disinfecting where there is much organic matter present, as there is in sputum and in the discharges from persons sick with typhoid or other intestinal diseases. It is very poisonous.

*Biniodid of mercury* is more than twice as powerful as bichlorid of mercury, and need be made only half as strong. It is one of the best general disinfectants, and is especially useful in disinfecting the hands, since it

does not injure the skin. It can be used on metals, and is useful for disinfecting instruments.

*Carbolic acid*, made up in a $2\frac{1}{2}$ per cent solution ($3\frac{1}{2}$ ounces of liquid carbolic acid to a gallon of water, or seven teaspoonfuls to a pint), is a good disinfectant. For disinfecting sputum and other discharges from the body it is well to use a 5 per cent solution.

*Lysol* is a stronger disinfectant than carbolic acid. It often destroys the colors in clothing. For sputum it is one of the best disinfectants.

*Chlorid of lime*, used in the proportion of 4 ounces of chlorid of lime to 3 gallons of water, is a cheap and powerful disinfectant. It may be purchased in grocery stores, put up in tin cans under the name of bleaching powder. It cannot be used on colored clothing, and the solution must be freshly made.

*Milk of lime* is a powerful disinfectant. To make the solution, add one part of freshly slaked lime by weight to four parts of water; or add the hard lumps of quicklime to the water and stir until a thick whitewash is formed. This is a cheap disinfectant, and for disinfecting the body wastes it is as good as anything that can be used. It should not be used in sinks, for it will cause trouble with the traps. Air-slaked lime (lime that has crumbled into fine powder from contact with the air) is worthless, and only quicklime should be used.

**Special points in disinfecting.** In caring for a case of infectious disease it is well to understand the following special points in disinfection:—

*Disinfecting the hands.* Any one who is caring for a person sick with an infectious disease should frequently sterilize his hands by holding them in a disinfectant

Washing the hands thoroughly in a soapy lather will almost free them from germs, and before eating they should be washed in this way and then disinfected. Keeping the nails trimmed and the skin smooth makes the hands much easier to disinfect. The hands of a person who is sick with a germ disease should frequently be washed with soap and water, and should be disinfected occasionally.

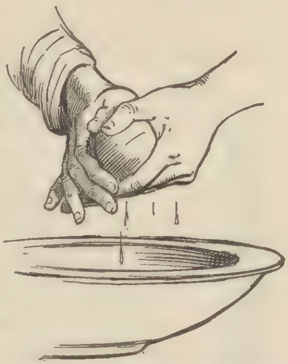


FIG. 101. Washing the hands thoroughly with soap and water helps to free them from germs.

*Disinfecting body wastes.* In typhoid fever and dysentery, the discharges from the intestines and kidneys should be received in vessels containing disinfectants. A strong solution of either chlorid of lime or milk of lime is excellent for this purpose. It is necessary to see that the disinfectant is thoroughly mixed with the waste matter, and it should be allowed to stand for several hours to make sure that all germs are killed. Any matter that is vomited by the patient may contain the germs, and should be treated in the same way as the intestinal and kidney discharges, and all handkerchiefs that a patient may use should be put into hot water or a disinfectant. The wastes from the alimentary canal should be disinfected in consumption and other respiratory diseases as well as in intestinal diseases. Even where there is water sewerage and these wastes can be thrown into the closet with little danger to the family

of the sick person, still they ought to be disinfected; for the germs may reach the water supply of another town, and some one may suffer from them.

*Disinfecting in diseases where germs are in the nose and mouth.* In diphtheria, pneumonia, consumption, influenza, measles, scarlet fever, and epidemic cerebro-spinal meningitis, the germs are in the discharges from the throat and nose. The instructions given on page 56 for disinfection in cases of consumption apply in all these diseases.

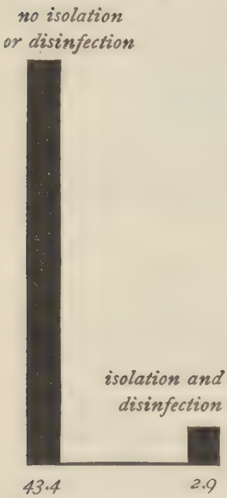



FIG. 102. In Michigan, from 1890 to 1903, there were on an average 43.4 cases in each outbreak of measles where isolation and disinfection were not practised; in each outbreak where these measures were put in force, there were, on an average, only 2.9 cases. (From report of Michigan State Board of Health.)

*Disinfecting buildings.* Where a room or whole house is to be disinfected, it is usually done by fumigating. Formaldehyde is best for this purpose. Special directions are necessary for this work if it is to be done effectively. Quicklime is a good disinfectant for cellars and closets.

**Mistaken ideas in regard to disinfection.** It is a common idea that there is some connection between the smell of a substance and its power as a germ-killer. Strong-smelling substances are sometimes burned in sick rooms, or a little carbolic acid is exposed in a saucer, so that it will scent the air of the room. It need hardly be pointed out that germs are not injured by anything of this kind.

**The importance of disinfection**. Our second great law for the prevention of germ diseases was to keep germs from the bodies of the sick from being scattered abroad. This can be done only by disinfection, and if all families would learn the value of disinfection and practise it, perhaps the most important step in the prevention of germ diseases would be taken.

**Isolating the sick**. People need to learn that sick persons should be kept away from those who are in health. This is best for both the sick and the well. It is possible to practise disinfection efficiently only when a sick person is kept in a room by himself, and the careless visiting in sick rooms which is allowed in colleges, boarding schools, and most families, is a cause of much disease. Figure 102 shows how effective isolation and disinfection are in checking the spread of measles, one of the most infectious of all diseases.

### POINTS TO BE REMEMBERED

1. Disease germs come from the bodies of diseased people.
2. Light and drying kill germs.
3. Heat is an excellent disinfectant.
4. Certain chemicals poison and kill germs.
5. A physician should be consulted as to the best disinfectants to use for particular purposes.
6. There is no reason to think that a substance is of any value as a disinfectant because it has a strong odor.
7. Disinfection and isolation are very important measures in checking the spread of germ diseases.

# CHAPTER THIRTY-TWO

## UNHYGIENIC HABITS

As we have said again and again in former chapters, nearly all disease germs leave the body by way of the mouth and nose, or in the wastes from the alimentary canal and kidneys, and most of them get into the body through the mouth and the nose, especially through the mouth. In their daily life, many persons have fallen into certain habits that make it easy for germs to get into the mouth and nose, and into other habits that scatter germs abroad where they are likely to do harm.

FIG. 103. It is never safe to use public drinking cups.

**Putting objects into the mouth.** The habit of putting into the mouth pencils, coins, candy, chewing gum, or any other object that has been in the mouth of another person, gives germs an opportunity to pass directly from

one mouth to another. A public drinking cup on a train, at a public fountain, or in a school, is certain to be used by some one with disease germs in his mouth.[1] If another person then drinks from the cup, the germs have as good an opportunity as a germ could wish to pass into the mouth unweakened by drying. Each pupil in a school should have his own cup, and a private cup should always be carried when traveling; but if it is necessary to drink from a public cup, it is best to put both lips into the cup while drinking. This is because the germs are more likely to be sticking to the edge of the cup (in mucus from the lips of persons who have previously used the cup) than to be floating free in the water.

FIG. 104. Rubbing the eyes and putting the hands to the face are bad habits.

**Putting the hands to the face.** Another habit that we would mention is that of allowing the fingers to touch the face, eyes, or lips. In many ways — from books, doorknobs, pencils, seats, and straps in street cars, and from the hands of other persons — we get germs on our hands. It is advisable, therefore, to form the habit of keeping the hands away from the face. Especial attention should be given to this point when sore eyes are prevalent. Before eating,

[1] On a drinking glass that had been touched by the lips, 20,000 bacteria were found, and 5000 on a glass slip touched by a thumb moistened with saliva, as the leaves of a book are often touched with a moistened finger or thumb in turning them.

the hands should be thoroughly washed with soap, for this is a very wonderful remover of germs.

**Exchanging books in the schoolroom**. Where school-books are furnished by the town or state, they are sometimes given out each morning, and it is only by chance that a pupil receives the same book on two successive days. This is not right, for the germs of diphtheria, pneumonia, scarlet fever, and of other dangerous diseases may be spread through a school by the books. Each child should keep the same books throughout the year, and passing books about from one pupil to another should be discouraged. It might be added that writing paper is more sanitary than the slates that are still in use in some places, for slates are often wet with saliva, and the sponges that are used on them are generally reeking with germs.

**Drinking water to which one is not accustomed**. When one is away from home on a short journey (as on a visit to a city or to an exposition), it is often not possible to be sure whether the water that is provided for drinking purposes is safe or not. It is, therefore, the part of wisdom to take a supply of water from home, or to drink mineral water or boiled water, or even tea or coffee. By drinking water from various sources, while on their vacations, hundreds of people every summer contract typhoid fever. Strangers coming into a place that has an impure water supply are always far more liable to contract typhoid fever than the inhabitants of the place, who are accustomed to the water, and almost any strange water is likely to cause intestinal disturbances that may spoil all the pleasure of a short visit or excursion.

**Spitting**. In previous chapters your attention has been repeatedly called to the fact that many germs may be in the mouth. That these germs are certainly scattered about by spitting, every one must understand. Tobacco spit is as bad as any other kind of spit, and every one must learn that to spit at all is not only an unclean and disgusting habit, but one that is very insanitary. Many cities have laws against spitting in public places. These laws are founded on common sense and should be supported by all good citizens. Every one should at least have enough care for others to spit in the gutter and not on the sidewalk, for on the sidewalk the germs are almost certain to be carried on the feet of passers-by into houses, stores, and offices.

**Washing the teeth in wash basins.** Cleaning the teeth in a wash basin will leave any germs that may be in the mouth in the wash basin, and you will readily understand how easy it would be for a few hundred thousand of these germs to get to the mouth of some one else who washes his face in the basin. A bathroom should have a sink over which the teeth may be cleaned, and in cars and public wash rooms some other place than the wash basins should be provided for cleaning the teeth. In a public wash room the safest plan is to turn on the water and wash in the stream as it comes from the faucet.

**Scattering the germs of intestinal diseases.** We come now to one of the most important and the most difficult of all the questions of sanitation, the question of how to prevent the spread of the germs of intestinal diseases. It is utterly amazing the way these germs now get scattered abroad, and the more we study the subject

the more we realize how unclean a creature man really is; for we must remember that every one of the million of cases of intestinal diseases that occur yearly are caused by germs that have escaped from the human body in the wastes from the alimentary canal and kidneys. In towns and in the country, where there is no water supply, the greatest care must be taken in disposing of these wastes, or disease will surely come from them. Where a city is supplied with water and has a sewer system, it is not difficult for a person or a family to know how to dispose of these wastes; but if the city disposes of its sewage by running it into the nearest stream, the people down the stream will probably suffer.

**The danger of polluting soils.** In the last few years a very important discovery has been made. This discovery is that it is not an uncommon thing for healthy persons to carry very dangerous germs, and that the germs of all the infectious diseases of the intestine (cholera, typhoid, dysentery, and diarrhea) may be carried by persons who are not themselves ill (page 79). So many cases of intestinal diseases come from well persons, that it is unsafe to allow the soil about a house to be polluted by the wastes of any human being, whether he be sick or well. If the soil does become infected with dangerous germs, these germs will be carried about by flies, they will be taken by the feet into houses and to well platforms, and sooner or later they will almost certainly reach the mouths of others. Also, the intestinal worms (page 135) that are so great a scourge in the southern part of the United States are spread entirely through the pollution of the soil. It is perfectly evident that no wastes from the

human body should under any circumstances be allowed to touch the soil of dooryards. Closets where these

FIG. 105. Children often become infected with disease germs by playing in unclean places.

wastes can be kept from becoming scattered and the germs in them can be destroyed, should be built.[1]

**Allowing children to play in the dirt.** It is the children, more than any other persons, who suffer from germ

[1] The discharges from the kidneys are dangerous as well as the intestinal discharges, for they very commonly contain streptococci, and they may contain the bacilli of typhoid fever.

diseases. One reason, and doubtless the main reason, for this is that children have less resistance to these diseases than have those who have grown up. Another reason is that children crawl and play on the floor and earth where their elders spit, and where all kinds of dangerous germs are left by the feet of those who have walked on the streets or on polluted soil about the house. Babies should not be put down to play on dirty floors or in dirty yards, nor should they be allowed to put into their mouths objects that have been soiled by dropping them in such places. More than any one else little children need to be guarded against germs, and for their sakes, especially, floors and yards should be kept as clean as possible.

## POINTS TO BE REMEMBERED

1. Many people have fallen into habits that make it easy for germs to get into the mouth and nose.
2. Putting objects into the mouth, drinking from public cups, allowing the fingers to touch the face and lips, and drinking water from unknown sources, give germs an opportunity to enter the body.
3. Spitting, cleaning the teeth in wash basins, and polluting the soil are practices that scatter disease germs.
4. The disposal of sewage and the prevention of soil pollution are among the most important questions in all sanitation.
5. Children should not be allowed to play in the dirt, for children, more than older persons, suffer from germ diseases.

# CHAPTER THIRTY-THREE

## PUBLIC SANITATION

THE wild man of the forest lives to a great extent alone, but civilized people cannot be independent of each other. Civilized people therefore have governments. The advantages of having a government are so many and so great that no person of intelligence can fail to understand them. Many persons, however, fall into the habit of complaining about their taxes, and fail to understand that the government is a great partnership into which all the people have entered for the good of all, and that for no other money expended do they get so much in return as for the money paid to the government. We will therefore turn away for a short time from the study of sanitation while we try to get a clearer idea of the advantages that come from having a government — advantages so plain that they have caused every civilized people that has ever existed on the earth to establish a government.

**The advantages of government.** Each person who walks the streets of a city cannot hire a policeman to protect him, and it would not be possible for every family to own a fire engine. Every farmer who wishes to drive over the country cannot afford to build roads and bridges wherever he may wish to go, and only a few families have enough wealth to pay the entire cost of a capable teacher for their children. But if each family will pay but a small sum into the public treasury, the government can provide police and fire departments, look after the roads, and educate the children of all the people. A government is of advantage to the people who live under it *because at a small cost to each person it*

*gives to its citizens many advantages that they could not have in any other way.*

In a city firearms should not be used, and automobiles and wagons should not be driven too rapidly through crowded streets, because if this is done, many accidents are sure to occur. In the country, a farmer should not turn his cattle and horses out on the public road, for they may injure his neighbor's crops. Yet no one person has authority to lay down rules in regard to the way another shall use a gun or drive an automobile or a wagon, and one farmer cannot force another to keep his cattle off the roads. Only a government with authority over all the people can do this, and it is a great advantage to have a government *that can forbid every one's doing those things that are harmful to the welfare of others;* for there have always been and are now in the world many persons who have little regard for the rights of others.

**Government a partnership.** From the above you will see that in reality a government is a great partnership. Each partner (citizen) is forbidden to do those things that would be injurious to others, and each partner is required to pay a certain sum of money (his taxes) into the public treasury each year. With this money the government hires done those things that are necessary for the welfare of all. One of the first duties of a government is to guard the health of its people, for as long as a community is greatly afflicted with disease, it cannot make much progress and its people cannot have much happiness.

**The need for public health officials.** It is not possible for an individual to protect himself from disease if those about him are carelessly scattering germs abroad

Only some one with authority over all the people can guard the health of a community, and public health officials are absolutely necessary if sanitary measures are to be enforced. Only those who have been specially trained for the work have the skill that is necessary to fight infectious diseases successfully, only those who are paid to do so can give to the work the time and attention that are required to make the fight successful, and only those with authority to do so can compel careless and unclean citizens to live in a sanitary manner. Without health officials certain persons in every community will keep breeding places for mosquitoes, hatch swarms of flies in great manure piles on their premises, spit on the sidewalks and in other public places, neglect to be vaccinated, or go straight out among the people from cases of very dangerous and very infectious diseases. Without officers of the law certain bad citizens always rob and steal, and these citizens must be forced to let the property of others alone. So in matters of sanitation, the ignorant and the careless citizens must be forced to live so that they will not be a source of danger to those about them.

**Supporting health officials.** No thief thinks well of the policeman who arrests him, and no murderer loves the judge who sentences him to be hanged. So the persons who are compelled to clean up their premises and live so that they will not be a nuisance and a source of danger to their neighbors often become angry with the health officials and try to injure them and hinder their work.[1] It is therefore the duty of every one to

[1] The greatest problem of the health official is the influential citizen who opposes any measures that may inconvenience him and insists on his right to

assist and encourage health officials, and we should always remember that they are trying to save us and not themselves from disease. Whatever they do is done for the good of the people over whom they are watching, and no man can claim to be a good citizen if he deliberately hinders one who is trying to save helpless men and women and innocent little children from disease and death. Especially should a man who claims to be a good citizen, stay in quarantine when he is ordered to do so. For deliberately to scatter abroad disease germs is a crime, and the man who does it knowingly deserves to be treated as other criminals are treated.

**The economy of public sanitation.** Many persons agree that public sanitation is a good thing, but think that the town or state in which they live cannot afford it. These persons do not understand what preventable diseases are costing their communities, or they do not understand political economy. For any man can afford to spend two dollars if thereby he can save ten dollars, and any community that spends money on public sanitation will save far more in the time that has been lost on account of sickness than it spent in trying to preserve the health of its citizens. The typhoid epidemic at Plymouth, Pennsylvania, cost nearly $100,000, and the persons who died in it were earning in wages $18,000 a year. Lawrence, Massachusetts, put in a water filter, and in four months the filter prevented enough typhoid to pay for itself. If the American people would use one half the sum that tuberculosis is costing them each year in fighting the disease, it is probable that tuberculosis would soon cease

be a menace and a nuisance to all his neighbors. — AN AMERICAN HEALTH OFFICIAL.

to exist. A conservative estimate places the cost of preventable germ diseases in this country at $1,500,000,000 a year, and if this money were used in fighting these diseases, most of them would soon be practically stamped out. The United States government appropriated $100,000 to destroy rats around San Francisco, and some persons thought that this was a great sum of money to spend for such a purpose. Yet the rats themselves, to say nothing of the plague that they carry, do six hundred thousand dollars' worth of damage every year in a city like San Francisco, and in the whole country they do fifty million dollars' worth of damage. Many towns everywhere think they cannot afford a public water supply, and yet every few years each one of these towns pays out more than the cost of a water system because of intestinal diseases. One such town the writer knows, a town of about two thousand inhabitants. Every year this town has from twenty to thirty cases of typhoid fever (besides other intestinal diseases) with two or three deaths, and every two years the people of the town spend enough on typhoid fever alone to pay for the water system that they think they cannot afford. Count up the number of cases of typhoid fever, the number of cases of consumption, or the number of persons who suffer from malaria in your town, and see if the people of the town are not acting in a very extravagant manner when they neglect public sanitation. You will certainly find this to be the case.

**The common sense of sanitation.** In a former chapter (page 144) we spoke of the sanity of sanitation. At this time we wish to call attention again to the fact that it is foolish to live in a way that we know will lead to dis-

ease. It is cheaper to live in a town where the sidewalks are clean, the streets sprinkled, the houses supplied with pure water, the sewage safely cared for, the milk supply clean, flies and mosquitoes banished, and skilled health officers employed to watch for and prevent infectious diseases, than it is to live in an insanitary town. It is certainly more pleasant to live in a clean than in an unclean town ; at least it is more pleasant to be well in a clean town than it is to be sick in an unclean one. The only sensible thing for any community to do, therefore, is to have public sanitation, and free itself as much as possible from germ diseases.

### POINTS TO BE REMEMBERED

1. In civilized communities no one lives to himself, and governments are necessary.
2. Governments give to their citizens many advantages that they otherwise could not have, and they prevent the ignorant and selfish citizens from harming others.
3. In a government each citizen is a partner.
4. The preservation of the public health is one of the first duties of a government.
5. Public health officials are necessary to carry out sanitary measures.
6. Good citizens should support health officials.
7. Sanitation is economical, for it is cheaper — very much cheaper — to prevent most germ diseases than to suffer from them.
8. Sanitation is sensible.

## CHAPTER THIRTY-FOUR

### WHAT GOVERNMENTS CAN DO TO PRESERVE THE PUBLIC HEALTH

JUST what a government should do to preserve the health of its citizens depends on whether the people over whom it is watching live in the tropics or in the colder portions of the earth, and on whether they are in cities and towns or in the country. Yet the principles of sanitation are everywhere the same — *the government must do those things that are necessary to the health of the community which the people cannot do for themselves*, and *it must compel every one to live in such a way that he will not be dangerous to others.* From your study of former chapters of this book you will understand many of the duties of a government that are connected with preserving the health of a people. We will, however, point out a few of the more important ways in which a government can save its citizens from disease.

**Quarantining in cases of epidemic diseases.** One very important duty of a government is to quarantine cases of epidemic diseases. If you had a handful of weed seeds in a cup, you could easily destroy them by throwing them into the fire. But if some one should scatter these seeds over your garden and lawn, it might be a work of months to get rid of the weeds that would grow from them. So in epidemic diseases it is easy to quarantine a single patient and keep the germs from being spread abroad, but it is very difficult to control some of these diseases after the germs have been scattered. Some physicians, even, do not appreciate the importance of this fact, and instance after instance could be given of great epidemics of disease that could have been entirely prevented if the first cases had been promptly dealt with.

Not only may a community injure itself by failure to enforce quarantine, but it may injure some other community that is far away. The man who started the great smallpox epidemic in Montreal (page 124) came from Chicago, and the man who caused the typhoid epidemic at Plymouth, Pennsylvania (page 88), came from Philadelphia. What we need all over the country and all over the world is such careful quarantining of infectious diseases that they will be driven from the earth. Both for the sake of its own people and for the sake of people in other places, every community should enforce strict quarantine of each case of sickness that has the appearance of smallpox, yellow fever, diphtheria, or other epidemic disease, until it is known that the disease is one that is not dangerous to the public health.

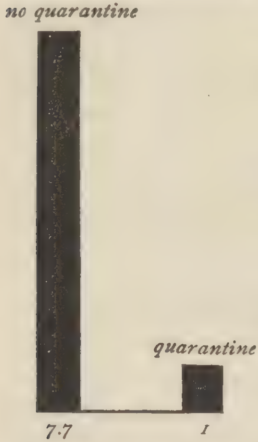



FIG. 106. From 1866 to 1875, when quarantine was not enforced, the average annual death rate from scarlet fever in Massachusetts was 7.7 for every 10,000 inhabitants. From 1896 to 1905, when quarantine was strictly enforced, the average annual death rate from scarlet fever was 1 for every 10,000 inhabitants.

**Building hospitals and sanatoria.** Governments should build hospitals to which persons who are suffering with severe epidemic diseases can be taken. This not only prevents the spread of these diseases, but is best for the patients also; for hospital physicians who have made a special study of epidemic diseases have the greatest skill and experience in treating diseases of this kind.

It is the duty of the government also to provide sanatoria where persons who are suffering from long-continued cases of infectious diseases can go. There are 500,000 consumptives in the United States, and in all the institutions of the country there are enough beds, pay or free for only a small part of these consumptives. Our country has no greater need today than sanatoria that will stop the spread of this disease and will give its victims the treatment that they need.

FIG. 107. Governments of cities and towns should keep down dust in the streets.

**Providing a pure water supply**. In the country it is usually possible for a family that is willing to use a reasonable amount of care and intelligence to provide itself with a pure water supply. In cities and in larger towns where the people are crowded together the soil always becomes polluted and well water is impure. It then becomes impossible for each family to secure a safe water supply, and it is the business of the city to furnish a supply of pure water for all the people. If a city fails to do this, many of its people will die of intestinal diseases. For the experience of the whole world is that cities and towns that must depend on shallow wells and on streams for their water are greatly scourged by intestinal diseases, while cities and towns that have pure water are comparatively free from these diseases.

**Providing a system of sewage disposal.** It is absolutely necessary for any government that wishes to preserve the health of its citizens to provide some method for the disposal of sewage. Where there is a water supply and a system of sewers, the problem is made easy for each family. Where there is no water and no such system of sewers, the government should take up the work of cleaning out all closets, and should provide carts to haul the matter in them away where it can do no harm.

FIG. 108. In a city the government should assist the citizens to keep their premises in a sanitary condition.

It is not enough for the government of a town to pass laws requiring that all closets be kept in a sanitary condition, for where families live on small lots the only safe way to dispose of the matter in closets is to haul it away, and it is a waste of money to require each separate family to hire this done when the government can have the same work done at a fraction of the cost to the people. In small towns that have no water supply the question of sewage disposal is of special importance. For the sanitary condition of a town is hopeless as long as it has neither a water supply nor a system of sewage disposal. It might be added that a town which provides some way of purifying its sewage before running it into a stream to infect the water supply of another town, is doing nothing more than to follow the Golden Rule.

**Collecting vital statistics.** In all the leading countries

of the world except the United States, a record is kept of all deaths and the causes of them. In over one half of our country, statistics in regard to the number of deaths and the diseases that cause them are collected, but in the remainder of the country this very important duty of the government is neglected.

**Why vital statistics are important.** If typhoid fever is a common disease in your town, the water supply needs to be improved. If a large number of little children are dying from intestinal diseases, the milk supply as well as the water supply should be looked after. If scarlet fever and diphtheria keep interfering with the schools and causing more deaths than they cause in other towns, your health officers are not quarantining and disinfecting as well as they do in other places. If the death rate from malaria is high, a campaign against mosquitoes should be undertaken.

How are we to find out whether or not infectious diseases are more common in a town than they should be? By keeping a record of all cases of these diseases and the number of deaths that they cause and comparing our figures with the figures from other places. How are we to tell which diseases are most important in our communities? By keeping a record and comparing the number of deaths caused by each. No one can tell what diseases are most common in a town without vital statistics. No one can tell whether or not sanitary measures are improving the health of a town as they should unless an account is kept of the number of deaths in the town before and after these measures are taken. All of us have lived among tuberculosis all our lives, but how many of us dreamed that tuberculosis was as im-

portant a disease as it is, until the facts were collected and set down in cold figures? "Let us have facts, real, unmistakable facts; for without facts there can be no true science."

**How death rates are calculated**. If you should examine the report of a health official, you would probably find in it death rates for the month or year for the city or state as a whole, and death rates for different diseases. At first these death rates may seem a little confusing, but when we understand how they are calculated they are in reality very simple. *The death rate of a country means the number of deaths in that country for each* 1000 *inhabitants*. In 1911 the death rate in the United States was 14.2 for that part of the country in which vital statistics are kept. For the same year it was 14.6 in England and Wales, 9.3 in New Zealand, 25.1 in Hungary, 13.8 in Sweden, 19.6 in France, and 23.2 in Spain. This means that in each of these countries there were as many deaths for each 1000 inhabitants as the figures given above show. Name some of these countries in which the sanitary conditions are probably not good.

*The death rates that are given for different diseases mean the number of deaths caused by these diseases for each* 100,000 *of population*. In 1910 the death rate from typhoid in England and Wales was 5. In the United States it was 23.5 (where statistics are kept). This means that in England and Wales there were 5 deaths from typhoid fever for each 100,000 of population, and in the United States there were 23.5 (more than four times as many) deaths from typhoid for each 100,000 inhabitants. In our country the death rate in 1912 was .3

from smallpox, 9.3 from whooping cough, 18.2 from diphtheria and croup, 149.5 from tuberculosis, 11.5 from meningitis, and 132.2 from pneumonia.

Which of these diseases is it most important for us to check? Why do you suppose typhoid fever is so much more common in the United States than in England? Look over the table on page 184 and suggest sanitary measures that the people of certain places ought to put into practice.

**How to study vital statistics.** The best way for you to begin the study of vital statistics is to examine the figures for your own city or town and then compare them with figures from other places. Ask your health officer for a copy of his last annual report and look for the tables showing the cases of infectious diseases and the causes of deaths. Make a table showing the number of deaths from these diseases and compare them with the figures from other places. Then make a list of the sanitary measures that you think would most improve the health of your town. If your health officer has no report of this kind, your town and your state ought to pass laws that will make it possible for vital statistics to be collected. For a health officer who is compelled to do his work without vital statistics is in exactly the same position that a merchant would be in if he were compelled to run his business without keeping any books.[1]

**Reporting cases of infectious diseases.** All cases of infectious diseases should be reported to the health officials, and they should keep a record of these cases.

[1] In some states very useful reports on vital statistics can be obtained from the State Registrar of Vital Statistics at the capital of the state.

## DEATH RATES IN THE UNITED STATES

| | General Death Rate | Typhoid Fever | Malaria | Smallpox | Measles | Scarlet Fever | Whooping Cough | Diphtheria and Croup | Tuberculosis (All Forms) | Tuberculosis of the Lungs | Meningitis | Pneumonia (All Forms) | Diarrhea and Similar Diseases (In Children under 2 years of Age) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United States: Total | 13.9 | 13.3 | 3.0 | 0.2 | 11.1 | 3.3 | 10.2 | 14.5 | 141.6 | 123.8 | 7.1 | 137.3 | 65.6 |
| White | 13.5 | 11.9 | 1.7 | 0.1 | 11.2 | 3.4 | 9.2 | 14.8 | 127.1 | 110.5 | 7.0 | 132.0 | 64.4 |
| Colored | 20.5 | 33.5 | 21.8 | 0.4 | 9.8 | 1.1 | 23.8 | 9.2 | 346.9 | 312.7 | 8.5 | 212.0 | 82.0 |
| Indiana | 13.6 | 21.5 | 1.4 | | 7.3 | 3.7 | 9.3 | 13.9 | 136.0 | 115.5 | 5.5 | 114.3 | 62.6 |
| Kentucky | 12.6 | 31.0 | 6.4 | 0.2 | 7.9 | 2.4 | 13.4 | 17.1 | 194.4 | 170.5 | 12.1 | 110.7 | 49.9 |
| White | 11.6 | 29.0 | 5.4 | 0.2 | 8.4 | 2.5 | 12.1 | 17.7 | 163.2 | 141.5 | 12.3 | 101.9 | 49.6 |
| Colored | 21.3 | 47.7 | 14.9 | | 4.0 | 0.8 | 24.2 | 12.5 | 463.4 | 420.9 | 10.5 | 187.0 | 52.9 |
| North Carolina | 13.1 | 29.2 | 14.0 | 0.5 | 7.1 | 2.6 | 16.7 | 17.1 | 148.9 | 134.9 | 9.8 | 104.8 | 77.9 |
| White | 11.4 | 22.6 | 9.2 | 0.3 | 6.9 | 3.5 | 10.7 | 20.0 | 103.5 | 92.0 | 9.9 | 84.1 | 74.5 |
| Colored | 16.8 | 43.8 | 24.6 | 1.1 | 7.6 | 0.5 | 29.9 | 10.6 | 248.5 | 228.9 | 9.4 | 149.9 | 85.2 |
| Pennsylvania | 14.6 | 13.6 | 0.2 | | 18.1 | 2.8 | 12.2 | 19.4 | 130.1 | 112.3 | 8.0 | 167.7 | 101.7 |
| Washington | 7.7 | 5.1 | 0.1 | 0.1 | 5.5 | 0.8 | 5.0 | 2.4 | 81.3 | 66.5 | 3.5 | 53.4 | 11.1 |
| San Francisco | 15.4 | 3.5 | 0.9 | | 1.3 | 1.7 | 3.9 | 28.3 | 193.6 | 169.4 | 4.5 | 129.0 | 18.1 |
| Chicago | 14.5 | 5.2 | 0.2 | | 5.4 | 6.4 | 4.0 | 31.5 | 150.2 | 132.8 | 7.5 | 158.1 | 141.4 |
| St. Louis | 14.9 | 9.4 | 1.6 | | 8.8 | 6.3 | 9.8 | 20.9 | 144.9 | 129.0 | 6.6 | 173.5 | 49.9 |
| New York City | 13.9 | 3.9 | 0.3 | | 9.9 | 2.2 | 6.9 | 18.5 | 173.7 | 154.9 | 5.7 | 179.9 | 58.1 |
| Your state | | | | | | | | | | | | | |
| Your city | | | | | | | | | | | | | |

The general death rate shows the number of deaths from all causes for each 1000 inhabitants. The death rates for the different diseases show the number of deaths from each of these diseases for each 100,000 inhabitants. Where more than ten per cent of the population is colored, the white and the colored death rates are given separately. The figures given are for 1916.

Then the officials can know whether children are attending school from a house where there is whooping cough or measles. They can then make sure that cases of scarlet fever and diphtheria are quarantined. They can see that the wastes from typhoid patients are destroyed, and they can do something to help consumptives and to prevent their spreading the disease. Every law providing for vital statistics should require physicians to report all cases of infectious disease to health officials as early as possible.

**Other duties of the government.** A government should further guard the health of its citizens by keeping a watch for germ carriers who may start epidemics, by disinfecting houses where consumptives have lived, and by vaccinating its citizens against smallpox. It should remove or cause to be removed the breeding places of flies and mosquitoes, and where there is danger of plague, it should wage war against rats. It should guard the milk supply, and put in force measures for keeping down dust. It should prohibit spitting in public to guard against consumption especially. Dispensaries where consumptives and mothers with sick babies can be advised and assisted are good investments for any city or state. It is also the duty of a government to provide sanitary school buildings and clean playgrounds for its future citizens, and to have medical inspectors keep

Vital statistics for any part of the United States where they are kept and estimated populations for non-census years for states and cities of more than 8000 inhabitants may be obtained from the annual reports on Mortality Statistics, published by the United States Bureau of the Census. Your health officer probably has a copy of this book, and he will doubtless allow you to copy from it any figures that you may need in your study of this subject.

watch over the children in the schools. Above all else a government should educate its people in regard to preventable diseases.

FIG. 109. In both city and country the public health nurse is becoming one of the most important agents in the prevention of sickness. Day after day she moves about among the people, advising them on matters of health.

### POINTS TO BE REMEMBERED

1. A government should quarantine epidemic diseases.
2. It should build hospitals and sanatoria where the victims of infectious diseases may be cared for.
3. It should provide a pure water supply for its citizens.
4. It should provide a system of sewage disposal.
5. It should collect vital statistics.
6. It should carry out such other measures as may be necessary to protect its citizens from preventable disease.

# CHAPTER THIRTY-FIVE

## PRACTICAL SANITATION

We have now made a study of the common germ diseases and of the sanitary methods that may be employed to prevent these diseases. The question now is, what can a few people do to improve the sanitary condition of a community? All great works take time, and to reform a town that is a total stranger to all sanitary measures usually requires years of patient effort. By intelligent work, however, a community can soon put itself in better sanitary condition and begin to cut down the number of deaths from infectious diseases in the community.

**Educating the public.** The chief trouble in carrying out sanitary measures is that many people do not understand anything at all about germ diseases. There are in our country many persons who do not yet know that malaria is carried by mosquitoes, or that a person who is only slightly ill, or not ill at all, may be carrying typhoid germs. These persons cannot understand the importance of sanitation. Neither do they carry out sanitary measures intelligently when they do try to improve the healthfulness of their surroundings, for it is an easy matter to look in the wrong place for germs. Every one, therefore, who spreads a knowledge of disease germs is helping the sanitary condition of his community, for where knowledge of disease germs goes, there intelligent and successful efforts to escape from them will soon follow.

**Sanitation in cities.** A great city can be kept in sanitary condition only by the government, and a citizen can best serve the cause of sanitation in a city by

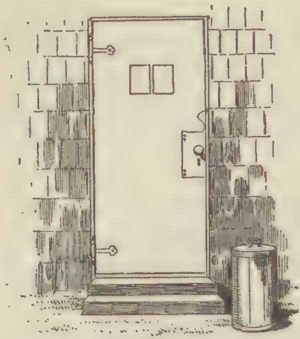
working through the health officials. The good citizen should use his powers to have honest, intelligent men elected to office, and he should support measures that will give these men enough money to have the health of the city properly guarded. In every city there are candidates for office who seek the support of the people by professing to believe in an economical government and a reduction of the taxes. In many cases it is possible to reduce the taxes only by allowing the schools, the police and fire departments, the streets, the parks and public playgrounds, and other interests of the city to run down, and by turning disease germs loose to work their will on the people of the city. The citizen who wishes sanitation in his city should therefore, first of all, interest himself in the life of the city and see that the right men are given control of public affairs, and he should advocate sanitary measures and everywhere preach the doctrine that public sanitation is not possible without expending public money. The citizen can also best do his part in the great sanitary work which a state and a nation should carry on by upholding faithful health officials and by reporting any who may be lazy or careless about their work.

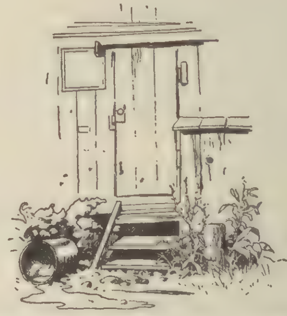
**Sanitation in villages.** From a sanitary point of view, the position of many villages and small towns is most melancholy. Enough people have collected in them to make it impossible for any one family to protect itself by its own sanitary efforts, as a family can do in the country. Even in a small town there are enough people to keep many rain barrels that will breed mosquitoes, many manure piles that will hatch flies, many offensive closets to threaten the health of the town. Enough peo-

ple can collect about the post office or the store in the smallest village to cover the sidewalk in front of the buildings (and sometimes the floors of the buildings themselves) with expectorations. At the same time, the small town usually has no water supply except wells, no system of sewage disposal, and no health officials who are paid enough and have authority enough to allow them to do much toward preserving the public health.

In these towns and villages much may be done for the cause of sanitation by a few intelligent, active workers. Village improvement associations can be organized to study how the town may be made a more healthful and pleasant place to live in. These associations can help to educate the people in regard to consumption and other diseases that are always in the village. They can keep before the public the necessity for having clean playgrounds for small children. They can encourage the people to sod along the sidewalks and to set out trees, and this will help in keeping down the dust. They can use their influence against spitting on sidewalks and can find other ways to assist in keeping the streets clean. Above all, they can uphold the physician who is acting as health officer when some one in the town becomes offended at him, and they can exercise a great influence on the officials of the town. If the members of a town council know that the intelligent people of the town want the breeding places of insects to be removed, the weeds in the streets to be cut down, the closets in the town to be kept in a sanitary condition, the streets to be sprinkled, and at the earliest possible moment a water supply to be provided for the town, they will be more likely to look

after these things than they will if no one thinks or says anything about the health conditions of the town.





FIGS. 110 and 111. Which of these will permit the people in the house to make the more effective fight for sanitation?

**Freeing the country farmhouse from disease.** In the country insanitary neighbors are not so great a danger as they are in towns and cities, and by intelligent effort a family in the country can to a great extent free itself from germ diseases. If country families will clear away weeds and dense shrubbery from around their homes, and look after the breeding places of mosquitoes, they can do much to protect themselves against malaria. By removing the breeding places of flies, avoiding the polluting of the soil about their homes, and guarding their milk and water supplies, they can in a great measure free themselves from intestinal diseases. Sunlight admitted freely to the house is one of the most powerful disinfectants known, and the fresh country air admitted freely to the sleeping rooms at night will do much to build up the body and increase its germicidal power.

Germ diseases are almost as common in the country as in the city, but with a little care a family in the country can avoid most of them.

**The necessity of setting a good example.** He who would be a successful preacher of any doctrine must himself be willing to put into practice that which he preaches, and he who would help the cause of sanitation

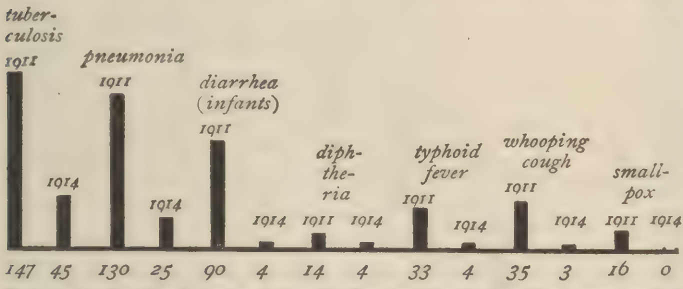



FIG. 112. In March, 1912, Robeson County, North Carolina, appointed a physician to give his whole time to looking after the health of the people. The diagram shows the number of deaths from certain diseases, in 1911, the year before the health officer began work, and in 1914, after he had been at work three years. Fifty-five per cent of the people in the county are colored.

in his community must first of all see that his own premises are in a clean and sanitary condition. The family that keeps a rain barrel to breed mosquitoes need not complain if a neighbor keeps a manure pile for the hatching of flies; the man who spits on the sidewalk need not be surprised if a passing consumptive leaves a swarm of tuberculosis germs by his front gate; and the family that keeps an offensive closet behind the house is in no position to make a successful fight for better sanitation in the town. The first and greatest service that we can render the cause of sanitation is to cease to offend against sanitary laws ourselves; and this will not be

without profit to us, for, after all, most families suffer from germ diseases more because of their own carelessness than because of the faults of others.

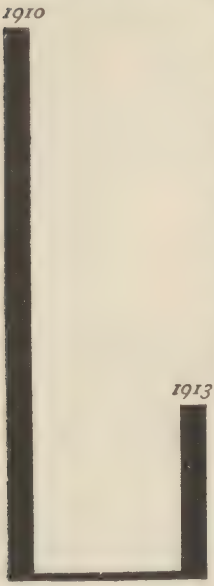



FIG. 113. Diagram showing the death rate from typhoid fever in Jacksonville, Florida. In 1910 there were 8500 open closets in the city. By 1913 these closets had been screened against flies. No other changes in the sanitary condition of the city that would affect the typhoid death rate were made during this time.

**Practical results of sanitation.** Sanitation is nothing new, for several thousand years ago the Jews kept their lepers under strict quarantine, and their laws called for a careful disposal of human wastes. By sanitary measures plague, smallpox, cholera, yellow fever, and typhus fever, formerly the greatest scourges of mankind, have practically been driven from the civilized world. By sanitation other germ diseases are rapidly being controlled, and there is hardly an infectious disease that can be mentioned that has not been either banished or seriously checked in many communities. For thousands of years sanitation has been tried and proved to be a great success, and its advocates today are only asking that the measures that have freed us from our worst plagues shall be used to free us from the lesser diseases that still afflict us. Figures 112 and 114 show what has been done in a few years to check some of these diseases, and as yet we have hardly begun to fight them with the idea of driving them from our land.

When we can keep the germs that are in the bodies of the sick from getting to those that are free from these germs, then nearly all cases of germ diseases will disap-

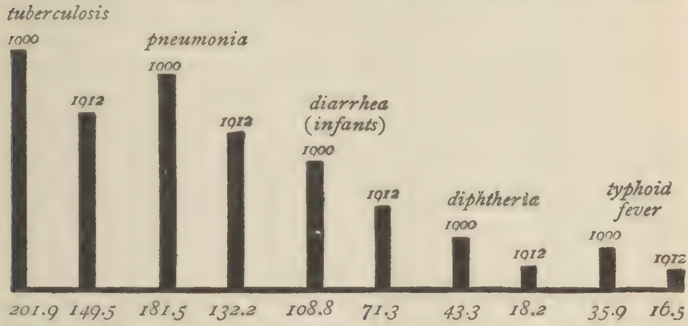



FIG. 114. Diagram showing the death rate (number of deaths per 100,000 inhabitants) from certain infectious diseases in 1900 and in 1912 in the part of the United States where vital statistics are kept. Sanitation is now saving tens of thousands of persons from dying of these diseases each year, and our health officials know how to save tens of thousands more.

pear from the earth. That it is possible to do this in the great majority of cases, all experience in sanitation abundantly proves.

### POINTS TO BE REMEMBERED

1. Education in regard to germ diseases always helps the cause of sanitation.
2. In cities, states, and nations, citizens can best serve the cause of sanitation by supporting the health officials.
3. Most small towns and villages need sanitary reform.
4. In these places much can be done for sanitation by educating the people and by interesting the local officials.
5. A country family can largely free itself from germ diseases.
6. Experience shows that by sanitation most germ diseases can be completely banished or at least greatly checked.

# CHAPTER THIRTY-SIX

## A NEW KIND OF DISEASE GERM

BACTERIA can easily pass through the pores of a brick or the pores in the walls of a vessel made of coarse clay, but if a liquid containing bacteria be passed through the walls of a filter made of the very finest clay, the bacteria will be strained out. There are certain diseases, however, the germs of which are so small that they pass through the finest filters. Some of these germs appear as mere points under even a powerful microscope, and many of them have not been seen at all. Most of them are like protozoa rather than bacteria, but all of them are much smaller than any bacteria or protozoa that we know and seem different from germs of these kinds. They are called *filtrable viruses*, — "filtrable" because they pass through a filter, and "viruses" because, long before the germ theory of disease was understood, physicians called that which passes from one person to another in an infectious disease the virus of the disease.

About forty diseases are now known to be caused by germs of this kind. One of them (mosaic disease of tobacco) is a plant disease. Many of them are animal diseases, hog cholera being the most important of these in our country. Among the human diseases that belong in this class are measles, smallpox, rabies, yellow fever, dengue fever, and infantile paralysis. The germs of scarlet fever, typhus fever, and trachoma probably are also of this kind, although there is some doubt about their passing through filters. We have already studied some of the best known of these diseases. Others with which we are less familiar we shall discuss at this time.

## INFANTILE PARALYSIS (POLIOMYELITIS)

Infantile paralysis was first described in 1881, and since that time it has been found in nearly all parts of the world. It seems to be becoming much more wide-spread year by year, especially in the United States. Its onset is sudden and severe, the spinal cord and brain being especially affected, and it often leaves the patient with some part of the body paralyzed. It attacks children under five years of age especially, but older persons also may suffer from it. The germs are found in the secretions from the nose and throat, and in the wastes from the alimentary canal.

**The germ of infantile paralysis.** Under a microscope the germ of infantile paralysis appears like a very small coccus, but it is much smaller than any known bacterium, — only about one fourth the diameter of one of the pus-forming cocci. It can withstand considerable drying, and can cause the disease in monkeys and rabbits as well as in man.

**How the disease is contracted.** Our present knowledge indicates that the germs of infantile paralysis are spread in the secretions of the nose and mouth. It has been proved that many healthy persons who are in contact with cases of the disease become carriers of the germs and spread the disease. To control infantile paralysis it is therefore necessary to quarantine not only the patients but also those who have been in contact with them. In 1916 a great epidemic of 9023 cases occurred in New York City. The history of this epidemic shows that vigorous measures are required to control the disease.

### LETHARGIC ENCEPHALITIS

This disease of the brain is sometimes called the "sleeping sickness" because the patient lies for long periods as if asleep. The germ is thought to be a filterable virus. Probably it enters and leaves the body through the mouth and nose.

### TYPHUS FEVER

Typhus fever is a very severe disease that was formerly known as ship fever, or jail fever, and was not clearly distinguished from typhoid fever. It has gradually disappeared from the United States, and except for occasional cases in the crowded parts of our cities, in our seaports, or on the Mexican border, it is no longer found among us. It is still common in the higher regions of Mexico and in other parts of the world.

The germ of typhus fever has not been discovered,[1] but it is known that it is in the blood, and that the disease is spread by the bite of the louse, especially the body louse. The method of preventing the disease is to destroy the vermin that carry the germs.

### ROCKY MOUNTAIN FEVER

This disease is especially prevalent in the Bitter Root Valley, Montana, but it is found also in Wyoming, Idaho, Washington, and other western states. The germ is carried by ticks, and the disease is contracted from the bite of an infected tick. How the germs get into the tick is not known, but some of the ticks found in nature are carrying them. The method of preventing the dis-

[1] It has recently been reported that typhus fever is caused by a bacillus that grows in the blood.

ease is to avoid the bites of ticks and to destroy the ticks. Methods of freeing land from these pests by grazing with sheep[1] and by destroying the ticks that attach themselves to other domestic animals are rapidly being worked out.

## TRACHOMA (GRANULATED LIDS)

Trachoma is a disease of the eyes that has been found to be very widespread in our country.[2] Many cases, especially in the early stages, appear to be mild, but some cases are very severe, and blindness is sometimes caused by it. It is a stubborn disease to cure, but it can be made to yield to proper medical treatment.

**The germ of trachoma.** Some investigators believe that trachoma is caused by the same germ that causes pink eye (page 97), — that it is a chronic form of pink eye in which the germs continue to grow in the eyes for years, forming little ulcers and scars (granules) in the linings of the lids and in the eyeball. The more commonly accepted idea is that it is caused by an undiscovered filtrable virus. The germs are in the secretions from the eyes, and trachoma is an infectious disease.

**Preventing the spread of trachoma.** The germs of trachoma doubtless get into the eyes from wash basins

[1] Ticks die unless they can attach themselves to an animal, and if a flock of sheep are allowed to graze over tick-infested territory, most of the ticks will attach themselves to the sheep. The oil on the wool of the sheep then coats over the small breathing pores of the tick, and 90 per cent of the ticks will be killed. Cattle, horses, and hogs are freed from ticks by spraying them with an insect-killing liquid, or by driving them through vats filled with a liquid of this kind.

[2] In some parts of the country, as many as twenty school children in a thousand have been found to be suffering with trachoma.

and towels, from the hands, and in other ways. The disease spreads through families and through schools, and a trachoma patient needs to take great care to guard the eyes of others from the germs. Any one whose eyes continue red or painful should have them examined at once by an oculist or a physician, and if he has trachoma, both for his own sake and for the sake of those about him, he should have his eyes treated. Until the patient is cured, he should not be allowed to attend school or other public gatherings where he may spread the disease.

### FOOT-AND-MOUTH DISEASE

Foot-and-mouth disease attacks cattle especially, but swine, sheep, goats, and other domestic animals, as well as man, may suffer from it. The disease gets its name from the fact that in cattle infected with it, blisters and sores appear in the mouth and on the delicate skin between and above the hoofs. It is very infectious, and in Europe it has given great trouble. In the United States it has been kept under better control, but in the winter of 1914–1915 a great outbreak occurred. It is caused by a filtrable virus, and the germs are in the milk, saliva, and other secretions, as well as in the sores. They remain alive for months if kept cool and moist, but die when they are dried. The effective methods of controlling the disease consist of preventing the shipment of cattle from infected areas, killing all cattle in infected herds, and Pasteurizing milk to prevent the disease in man. It is so infectious that it never remains hidden, and by using sufficiently energetic measures it is possible to keep it under control.

### FOWL TUMOR

Another animal disease that is caused by a filtrable virus is a kind of tumor in chickens. This disease has attracted much attention, because in it the cells multiply and grow in an unnatural manner, as they do in tumors and cancer in man. A small tumor that grows on the skin of the face in man is also known to be due to a virus of this kind, and some physicians have long believed that cancer is infectious and will finally prove to be a germ disease. It is most important to discover the cause of this disease; for cancer and tumors in our country are now causing nearly 75,000 deaths each year and they have increased greatly (probably 25 per cent) since 1900.

Warts have recently been reported as being due to a filterable virus. It has long been believed that one person can catch them from another.

### POINTS TO BE REMEMBERED

1. Some disease germs pass through the finest filters.
2. Measles, smallpox, rabies, yellow fever, and other common diseases are due to germs of this kind.
3. The germs of infantile paralysis are in the secretions from the mouth and nose and in the body wastes.
4. Cases of this disease should be carefully quarantined.
5. Typhus fever is contracted from the bite of the louse.
6. Rocky Mountain fever is contracted from the bite of a tick.
7. Cases of trachoma should be treated and quarantined.
8. Foot-and-mouth disease is a very infectious disease of cattle, which man may contract from milk.
9. Cancer may prove to be a germ disease.

# CHAPTER THIRTY-SEVEN

## NEW DISCOVERIES IN REGARD TO GERM DISEASES

It is now only about forty years since the germ theory of disease came to be understood, and it is wonderful that we should have learned so much about these diseases in so short a time. Our knowledge of them is still incomplete, however, and scientists are constantly studying them and the germs that cause them, and each year new discoveries in sanitation are being made. Many of these discoveries prove most valuable in the warfare against germs, and each year we learn better how to bring communicable diseases under control. In this chapter we shall study some important facts in preventive medicine that have been discovered in the last few years.

**A study of tuberculosis.** In 1913 in Minnesota, forty city families, in each of which a consumptive had been living for a year or more, were investigated. In every one of these families it was found that at least one other person was infected, and in ten of the families every member was infected. All together, there were in these forty families 207 persons living with consumptives, and of these 207 persons, 138 had contracted the disease. At the same time, fifteen families in which there were no consumptives were investigated, and in these families only two persons out of eighty were found to be infected. Other studies in the rural parts of Minnesota seemed to show that parts of counties where no consumptives had lived were entirely free from the disease, and that where it had been introduced into a community, it had spread to the families living on the farms close to the consumptives. It was also concluded

from these studies that the danger of infection depends on the amount of exposure to the germs; that the danger from a chance meeting with a consumptive, or from living in the house with him for a few days, is not great, but that there is great danger of infection if one lives with a consumptive for a long period of time and is exposed to great numbers of the germs day after day (page 151). This study indicates that isolating cases of tuberculosis is the most important measure in preventing the spread of tuberculosis, and in Minnesota a consumptive is required either to reside in a sanatorium or to live separate from the other members of the family in the home.

**Contact infection.** This study, like all the newer investigations of the subject, leads us to believe that it is not from air, dust, clothes, or furniture that germs usually reach us, but that they are passed in a rather direct way from one person to another on the hands, or on drinking cups, dishes, and other articles. This passing of germs from one person to another in large numbers and without giving them an opportunity to dry is called *contact infection*, and undoubtedly the great majority of cases of diseases like typhoid fever, pneumonia, influenza, diphtheria, whooping cough, scarlet fever, measles, and tuberculosis, originate in this way. So important indeed do some health officers now consider this method of infection, and so few cases of many diseases do they think come from houses, furniture, and clothes, that they have given up the disinfecting of houses after cases of diphtheria, measles, and scarlet fever, and are spending their energies in finding and isolating the persons who are carrying the germs.

The theory on which this practice is based is that when mucus and other matter containing germs is dried on desks, doorknobs, or other articles, the great majority of the germs die at once; that the others are weakened by the drying; and that the small number of weakened germs that one would get from articles of this kind is not dangerous like the great numbers of fresh germs that one may receive direct from the patient himself, or from something he has just handled.

**Two aids in preventing contact infection.** One of the most effective measures for preventing contact infection is medical inspection of schools, because where this is practised cases of infectious diseases are found in their early stages and removed before the germs spread to others.[1] Another great aid in preventing contact infection is hospitals for isolating cases of typhoid fever, pneumonia, influenza, diphtheria, and other like diseases. These hospitals can give patients suffering with such diseases better care, better nursing, and better medical attention than they receive in their homes; they can at once cut off much sickness by stopping the spread of these diseases through

FIG. 115. By medical inspection in schools, early cases of infectious diseases are discovered.

[1] One French sanitarian, in referring to the custom of disinfecting schoolrooms to stop the spread of measles, exclaimed: "The germs are in the nostrils of the children, and they disinfect the furniture!"

families; and they ought to be established in every county and town in the land.

**A safe disposal of human wastes.** Notwithstanding all the campaigns for sanitation that have been carried on in recent years, there are hundreds of thousands of farms in our land that are still without closets, and in villages, school grounds, church yards, and beside country homes, there are hundreds of thousands of open closets still in use. Any one who knows the habits of the housefly — how day after day it passes back and forth between these places and dining-rooms and kitchens — knows that as long as such a condition continues, not even a beginning in sanitation and hardly a beginning in civilization has been made. It cannot be too strongly insisted upon that one of the first and most important of all sanitary measures is to provide a safe means of disposing of human wastes, and a sanitary toilet arrangement should be a part of every human habitation in the land.[1]

**Screening against mosquitoes.** The ordinary screens that are placed on houses are fly screens, and not mosquito screens, and the meshes in them are so coarse that the mosquitoes that carry malaria and yellow fever can pass through them. To keep the malaria mosquito out

[1] Complete directions for building sanitary closets may be obtained from any State Board of Health, or from the United States Public Health Service, Washington, D.C. The International Health Board suggests that if nothing better can be provided, a box placed in the forest or among bushes may be turned, mouth down, over a small pit and moved from time to time. The box can be made fly-tight by banking the earth around it and covering the openings, and this is the most important point in the construction of a closet. When the box is moved, the pit should be filled with earth. It is not safe to use wastes from a closet as a fertilizer for gardens.

of a house requires a screen with about sixteen strands to the inch, and to turn the yellow fever mosquito, twenty wires to the inch are necessary. Galvanized or bronze screens will in the end prove cheaper than painted iron wire, and they permit the air to pass through them much more freely. Careful work is needed to make the screening on a house effective; for a feeding of blood is necessary to the female mosquito before she can lay her eggs, and she will search over screens until she finds the smallest crack or opening, or even come down chimneys, to get into a house. Since mosquitoes are attracted by light, lamps should be kept away from doors in the evening, and on a screened porch the lights should be placed at the other end from the door. It has been reported that ducks are most valuable in destroying the larvæ of mosquitoes, and that if ponds are kept free from the large fish that feed on minnows, the minnows will allow almost no mosquitoes to breed in the water.

**Bad after-effects of infectious diseases.** Recently an investigation has been made by the Metropolitan Life Insurance Company of New York, of the death rate among 1574 of its policy holders who suffered from attacks of typhoid fever in 1911. Of these 1574 persons, 146 died of the disease, and 1428 survived; but during the next three years fifty-four of these survivors died of other diseases, twenty-one of them of tuberculosis. This gave a death rate more than twice as high as was to be expected among persons of this age.[1]

[1] It is estimated that in the United States 178,200 persons survived attacks of typhoid fever in 1914, but that 7781 of these survivors will die inside of three years, because of the damage done them by the disease.

In the same way, bad after-effects follow measles, diphtheria, scarlet fever, influenza, pneumonia, and other germ diseases, and to take no account of these after-effects is like leaving out of account the wounded when one is reckoning the losses in war.

**Raising the defenses of the body by vaccination.** In the last few years the idea of preventing by vaccination certain diseases that are not well controlled by sanitation has gained great headway. Not only is this practised for the prevention of smallpox, rabies, and certain animal diseases, but vaccination against typhoid fever has now been proved to be a great success.[1] The same methods have been employed to check epidemics of cholera, plague, meningitis, and whooping cough; and some individuals have themselves vaccinated against colds, influenza, pneumonia, and other diseases.[2] The theory of all vaccination is the same, — weak or dead germs are introduced into the body, and this causes the germ-killing power of the body to be increased.

**The prevention of plague.** Plague is first of all a disease of rodents (animals like rats, mice, squirrels, prairie dogs, and rabbits), and the only way of fighting it is to fight the rats that are the principal carriers of it. Something can be done by trapping and poisoning them, but

[1] Formerly typhoid fever was the most dreaded of all camp diseases, and usually during war more soldiers died from it than from wounds. During the spring of 1911 the United States had a force of 15,000 soldiers, all vaccinated against typhoid fever, in camps in Texas, and only one case of the disease appeared among them.

[2] It is reported from Russia that epidemics of scarlet fever have been checked by vaccination against the pus-forming bacteria (streptococci) that are always present in this disease.

they multiply so rapidly that the only effective way of dealing with them is to cut off their food supply and break up their homes.[1] To do this it is necessary to keep garbage in covered cans; to rat-proof slaughter houses, mills, warehouses, and stores; to provide cement floors and rat-proof bins in livery stables and barns; and either to close rats out from under buildings and floors or to raise these enough for dogs and cats to pass freely under them. Houses should be built so that rats cannot get into cellars or walls, and all wharves should be rat-proof because of the danger of plague-infected rats landing from a vessel at any time. A campaign against rats is expensive, but it is more expensive to support an army of rats than it is to drive them out, even were there no question of health concerned.

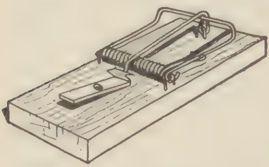


FIG. 116. The cheapest and most effective kind of rat trap.

**Hookworm in dogs.** It is reported that the disease called "black tongue" in dogs is caused by hookworms and that the infection among both dogs and cats is widespread. The hookworms that attack animals are different from those that infect human beings, but in general it is coming to be believed that we contract disease from animals more frequently than was formerly supposed, and that dogs and cats are not good companions for children.

[1] There are often ten or twelve rats in a litter, and a female white rat has been known to give birth to more than eighty young in a year. It is estimated that there are more rats than men sailing the seas; that in cities there are as many rats as people; and that in the country there is one rat to each acre of land. In California, plague spread from the rats to the ground squirrels in the country and has not yet been eradicated.

**Controlling epidemics of measles in schools.** Because the first symptoms of measles resemble a cold and the disease is often not recognized in its early stages; because it is highly infectious in these first stages; because cases of the disease are so mild that they are overlooked; because the germs are so powerful that they can successfully attack almost every one they can reach; and because its victims are chiefly small children,[1] measles is a most difficult disease to control. One useful plan in schools is as follows: When a pupil is attacked, the school is continued as usual for about eight days. Then the children who were exposed to the disease are kept out of school for a week. After this, all those who have not developed the disease or are not being exposed to it at home are allowed to return (page 132).

**A disease that has been confused with tuberculosis.** Recent investigations prove that a number of cases of supposed tuberculosis are not due to the tubercle bacillus, but to a threadlike fungus (*Nocardia*). It is not known how common this disease is, but it requires different treatment from tuberculosis, and it is important that it be distinguished from tuberculosis.

**Infectious jaundice.** This is a communicable disease in which the patient becomes yellow in color. Occasional cases and sometimes local epidemics of it occur in our country, and it proved troublesome in the trenches

[1] Diseases that attack small children do not receive the same attention as diseases that attack prominent citizens in the midst of their careers. The prevention of measles has, therefore, been neglected, and we have in our country during some years more than 1,000,000 cases with more than 10,000 deaths.

during the recent war. The germ lives in both man and the rat and leaves the body in the discharges from the kidneys and the bowels. It can be transferred from one person to another as typhoid germs are transferred, or the disease can be contracted from foodstuffs that have

FIG. 117. Isolation hospital for cases of infectious diseases at Jacksonville, Florida. To prevent the spreading of germs within the hospital, the water faucets and doors are arranged so that they may be opened with the elbows. The windows are covered with full-length screens to keep out flies and mosquitoes, but there is no fear that the germs will travel through the air and visitors are allowed to talk to patients through the windows.

been infected by rats. Many wild rats carry the germs, and it is dangerous to allow food to be soiled by them.

**Varieties of the pneumonia germ.** Recent investigations indicate that there are four races, or types, of the pneumonia germ. Three of the races are very dangerous and are commonly found only in the bodies of pneumonia patients or in the mouths of persons who are taking care of these patients. Germs of these three races cause nearly 80 per cent of all cases of pneumonia and more than 90 per cent of all deaths from the disease. These virulent types of germs, like the diphtheria germ, may remain in the mouths of patients for a

long time (twelve to ninety days) after the onset of the disease.

The fourth race of pneumonia germs is less dangerous than the others. It is found in the mouths of about 60 per cent of healthy persons, and if for any reason the defenses of the body are lowered, it may invade the lungs. About 20 per cent of pneumonia cases are due to this type of germ, but usually the attack is mild, and only about 6 per cent of the cases end in death.

**Pellagra.** Certain investigations made in recent years indicate that pellagra spreads only where the sanitary conditions are bad; that when villages are sewered and the precautions taken that prevent typhoid fever, new cases of pellagra do not develop. From this it has been inferred that it is caused by an undiscovered germ that is in the intestinal wastes, and that the disease can be prevented as intestinal diseases are prevented, — by pure water, pure milk, and a safe disposal of the body wastes.

On the other hand, there is much reason for believing that pellagra is due to a lack of proper food. In two orphan asylums, in which there were many cases, the sanitary conditions were left unchanged but a more liberal supply of milk, eggs, peas, beans, and oatmeal was provided in the diet. The previous year there had been seventy-nine cases of pellagra in one of the asylums and one hundred and thirty cases in the other. The year following the change in diet, barring recent admissions, there were no cases of the disease in one institution and only one case in the other. Because of facts like these some authorities have held that pellagra is a diet disease, and that it may be prevented by a

more abundant and more varied supply of food. Fresh meats, eggs, milk, peas, beans, whole grains, and fresh vegetables are foods that seem to protect against pellagra. Living on salt meats, canned goods, fine flour or fine corn meal, molasses, and foods cooked with soda is held to cause the disease. (See pages 354 and 356.)

Perhaps the explanation of these seemingly conflicting facts is that pellagra is a germ disease, but that a proper food supply raises the resistance of the body to the germs. Further investigations are necessary before a final decision in regard to the matter can be made.

### POINTS TO BE REMEMBERED

1. Recent studies indicate that most cases of tuberculosis come from living with consumptives.
2. Contact infection is supposed to be the principal method of spreading germs.
3. Hospitals and medical inspection of schools aid greatly in preventing contact infection.
4. Sanitary toilet arrangements should be a part of every human habitation.
5. Fine screens are required to keep out mosquitoes.
6. Many persons die because of the after-effects of infectious diseases.
7. The defenses of the body against many germs may be raised by vaccination.
8. Plague can be controlled only by fighting rats.
9. Some supposed cases of tuberculosis are due to fungi and yeasts.
10. A disease of the teeth is caused by an ameba.
11. There are several distinct races of the pneumonia germ.

# PART II

# PRIMER OF PHYSIOLOGY

# CHAPTER ONE

## THE POSSIBILITIES OF GOOD HEALTH

FIG. 1. The length of time a top will spin depends on the conditions under which the spinning is done.

THREE boys at the same time threw their tops into a ring drawn on the earth. One top struck a pebble, bounded into the air, and fell motionless on its side. Another top worked its way into a little sandy hollow in the earth, and in thirty seconds its spinning was over. The third top settled down on the smooth earth and continued to spin steadily and quietly for more than a minute.

How long will a top spin? It is not possible to answer this question definitely because the length of time it will spin depends on the conditions under which the spinning is done.

**Length of human life dependent on the care that is given the body.** In Europe three hundred years ago, the average human life was twenty years; today it is

forty years. At the present time it is in India twenty-four years and in Sweden fifty-two years. In New York City twelve years have been added to the average life since 1866, and in Indiana from 1900 to 1910 human life lengthened at the rate of six months each year. During this period, therefore, the people of Indiana may be said to have won back one-half the time that the passage of the years took from them.


FIG. 2. A diagram showing the average length of life in different parts of the world. The length of time the human body lasts depends on the care that it receives.

There is a common idea that the body has a certain "natural" lifetime. The facts show that this idea is incorrect. The engine of an automobile wears out in a month if it is neglected, and it lasts for years if it is given proper care. The human machine likewise has no definite length of life. It may be destroyed in its first month by impure milk; it may suddenly be wrecked by the germs of typhoid fever after it has been running smoothly for twenty-five years; or, if properly cared for, it may give good service for sixty, seventy, or even eighty years. A top spins longer on a smooth than on a rough surface; an automobile lasts longer when it is given proper care than when it receives rough treatment; and human life is longer when the body lives and works under favor-

able conditions than it is when the body is neglected and abused.

**The possibilities of preventing sickness.** In India, where the people live under bad sanitary conditions, there is a daily average of eighty-four sick persons for each one thousand of population. In Spain, for each one thousand inhabitants the daily average is fifty-six; in the United States it is thirty; and in New Zealand it is nineteen. In five of the largest European cities, in the year 1880, the daily average of sick persons was fifty-five for each one thousand inhabitants; by 1909 this average had fallen to thirty-one. In the United States there is still much preventable illness, but the sickness among us decreased 23 per cent between the years 1890 and 1909.

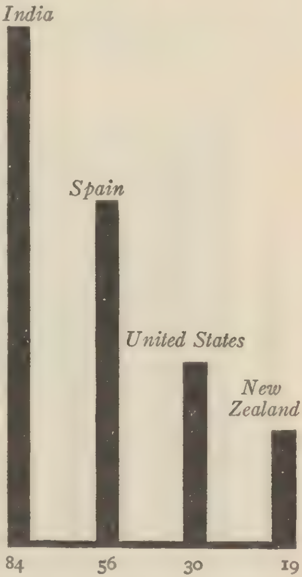



FIG. 3. A diagram showing the average daily number of sick persons per 1000 inhabitants in different countries. The amount of sickness in any country depends to a great extent on the degree of intelligence its people use in dealing with matters of health.

These facts prove that the amount of sickness in different countries depends on the degree of intelligence that the people use in dealing with matters of health. They show that each community has it largely in its own power to decide how many of its people shall each day be sick and how many of them shall be in health.

**Disease prevails because of ignorance.** In our own country there are at all times 1,500,000 persons seriously ill with preventable diseases. This means that each year we have 1,500,000 years of unnecessary sickness among us. Why do people undergo all this suffering if it is possible to escape it? It is because there still lingers in the common mind the age-old idea that disease is an unescapable thing sent upon us by the Fates, and that health comes because of good fortune and not because it is deserved or earned.

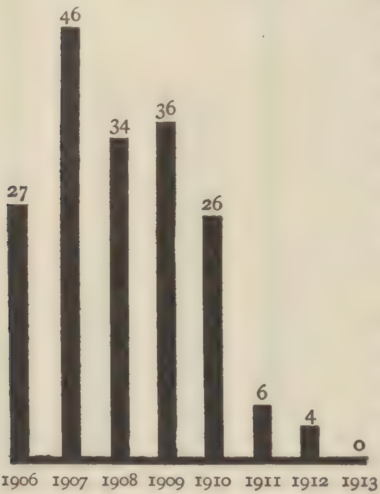
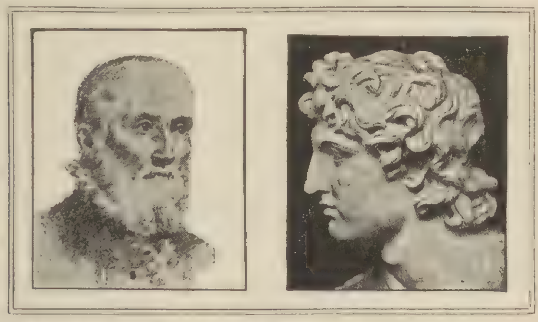



FIG. 4. A diagram showing the number of typhoid fever cases in Williamsburg, Virginia, from 1906 to 1913. In 1911 the closets were screened, so that flies could not carry typhoid germs about the town.

We now know that this belief is incorrect; that if men are willing to work for health and to earn it, they may, in the great majority of cases, have it. Within the last forty years the real causes of most diseases have been discovered; the methods of preventing them have been worked out. Some of these discoveries we are taking advantage of, but many of them are not understood by the people, and as yet there is not a community in the world that will allow its health officers and physicians to use all their knowledge in the prevention of disease. The ancient Greeks

taught that knowledge is virtue and ignorance is sin. The great sin in the hygienic world today is ignorance, and we are punished for this ignorance by the preventable illness that is among us.

**Learning to keep the laws of life.** Cut your finger and you will suffer; burn your hand and you will smart for it. Observe the laws under which your body lives and you



FIGS. 5 and 6. Louis Cornaro and Alexander the Great. Alexander, a daring and all-conquering warrior of the ancient world, died at the age of 33 because he paid no attention to his health. Cornaro, who was an Italian nobleman, lived from 1464 to 1566 — 102 years. When he was 40 years old he was told by his physicians that he would die, but he gave great attention to hygiene, regained his health, and lived to enjoy a life of profit to himself and others.

will enjoy health; break them and you must bear the punishment. Whether you like these laws or not has nothing to do with the question. You did not make them; you cannot change them. All that you can do is to find out what they are and then obey them. As you go through life, you will doubtless find certain persons who do not wish to recognize the existence of these laws and who are trying to find some means of escaping from them. This is impossible; for Nature's decrees are unyielding and unchangeable. The sensible course, there-

fore, is to listen to the commands of Nature, to learn her laws and give obedience to them. In this book we shall study the human body and the laws of its life.

### QUESTIONS

What was the average length of life in Europe 300 years ago? What is the average length of life at the present time in India? in Sweden? In New York City how much has been added to the average life since 1866? How rapidly was life lengthened in Indiana from 1900 to 1910? Is there a "natural" lifetime for the body? Give a reason for your answer. How many persons are sick each day for each 1000 inhabitants in India? in Spain? in the United States? in New Zealand?

How much has sickness decreased in certain European cities during the last 30 years? in the United States during the last 20 years? How much preventable illness is there in the United States each year? Why do people allow this sickness among them? What result follows the keeping of Nature's laws? What is the result of breaking these laws? What course should we pursue with regard to them?

### SUGGESTIONS TO THE TEACHER

Keep before the class at all times the idea that health is the normal condition of the body and that disease is in the main preventable. Make the pupils realize that health conservation has ceased to be a scientific problem and has become a social and educational problem; that science has pointed out how to save annually in the United States 600,000 lives and how to prevent most of the sickness from which we suffer.

Secure from local city and state boards of health whatever vital statistics are available and point out the great number of deaths occurring locally from preventable diseases. For suggestions as to additional material that may be used with this chapter, see page 227.

# CHAPTER TWO

## THE HUMAN BODY AND THE CELLS OF WHICH IT IS BUILT

HAVE you ever watched a little plant push its way out of a seed, thrust its roots downward into the earth, and unfold its leaves to the light? And have you seen such a plant grow larger day by day, until finally it blossomed and bore seeds like the parent seed from which it grew? If you have worked in a garden and understand plants, you must often have thought that they are very much like the people about us in the way they grow and go through the cycle of their lives. This is indeed the truth, and, in order that you may better understand your own bodies, we shall begin this chapter by learning something of the structure of a plant and of how a plant grows.

FIG. 7. The life cycle of the bean.

**A plant composed of cells**. If you could examine a small portion of a leaf or other living part of a plant under a microscope, you would find that it is composed of little parts built together, as stones are built together to make a wall. The little parts of which the plant is built are called *cells*. Each cell is composed of a half-liquid living material, which is inclosed by a cell wall. In the center of the living matter is a denser portion, which is called

the *nucleus*. All the living parts of a plant are composed of cells.

**How the young plant starts from a cell called the egg.** Break open a seed and you will find in it a young plant. Where did it come from? It grew from a cell called the *egg*. This cell at first is like the other cells of which the seed is built, but at a certain time it increases

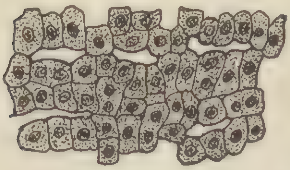


FIG. 8. Cells from the liver, as seen under a microscope, highly magnified.

FIG. 9. Cells drawn diagrammatically to show the spaces among them, highly magnified.

in size and gathers to itself a rich food supply. It then begins to divide, and from it the new plant comes. Before we begin the story of its growth, however, there are some other things that it is well for us to understand.

**The parts of a flower.** Examine almost any common flower, and you will have no trouble in recognizing the

FIG. 10. A pine seed cut open to show the young plant in it.

parts shown in Figure 11. First come the little green *sepals*, then the bright-colored *petals*, next the *stamens*, and in the center one or more *pistils*. The lower part of the pistil contains the young seeds and becomes the seed pod. In the heads of the stamens is a fine, powdery substance called *pollen*. When we examine pollen under a microscope, we see that it is composed of a great number of little grains. Each

little grain is, in reality, a cell; each contains living matter and a nucleus, as do other cells.

**The egg fertilized by the pollen.** Bees visit flowers for the nectar that is in the blossoms and for the pollen, which they gather and mix with honey in making "bee bread" for their young. In passing into a flower and out of it, a bee often leaves pollen on the sticky outer end of the pistil. When a pollen grain is thus left on a pistil, a long, thread-like tube grows out from it, makes its way down through the pistil to a young seed, enters the seed, and finds the egg (Fig. 13). Then a nucleus from the pollen grain passes out of the tube and unites with the nucleus of the egg. The uniting of the nucleus of the pollen grain with the nucleus of the egg is called *fertilization*, and the egg is said to be *fertilized*, because in some way it is given the power to grow and make a new plant.[1]

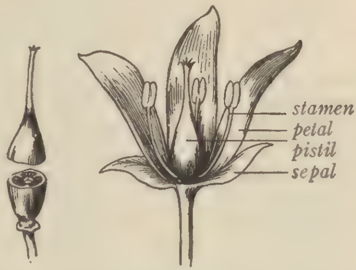



FIG. 11. The parts of a flower. To the left is a pistil cut open to show the location of the young seeds.

FIG. 12. Pollen grains. On the left a pollen tube is shown growing out from the grain.

**The growth of the egg into a new plant.** After the egg is fertilized, it begins to grow. In a very short time

[1] When the pollen is washed away by rains, or when the spring is so cold and wet that bees and other insects cannot visit the flowers, the strawberry, plum, peach, and cherry crops fail. Without the pollen the eggs in the young seeds do not grow. the seeds die, and the fruit drops off.

it divides into two cells. Each of these again divides, making four cells, and the process goes on until there is a group of many cells, which have come from the dividing of the egg. From these cells are formed the roots, the stem, the leaves, and the other parts of the new plant. The outer ones change into skin or bark to protect the delicate living cells within. Some change into long wooden vessels to carry water from the earth up to the leaves; some form vessels for carrying food throughout the plant; and other cells take up all the different kinds of work that must be done within the plant. Usually the little plant stops at a certain stage of growth and rests within the seed until the warmth of the next spring stirs the cells into renewed activity and calls the plant forth to a new life.

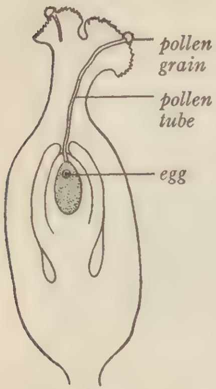



FIG. 13. Diagram showing how the pollen tube passes down through the pistil to the egg.

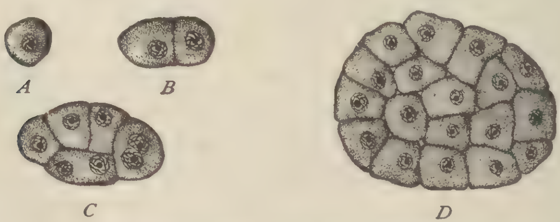
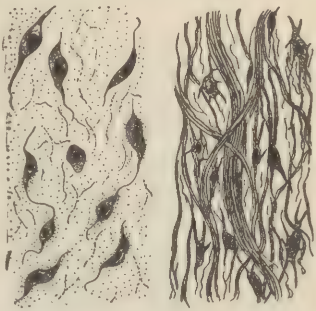



FIG. 14. Four stages in the development of the young plant from the egg. *A* represents the egg, *B* shows the division into two cells, and *C* and *D* are later stages. In two of the cells in *C*, the nuclei have divided, but the new cell walls have not yet been formed.

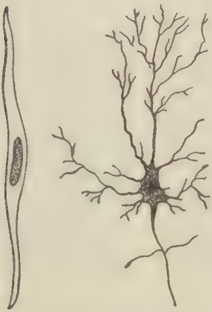
**The growth of the human body from a single cell.** The human body, like the body of a plant, starts from one cell. This cell divides and re-divides until it forms a great cluster of thousands of cells. Of these cells all the organs and parts of the body are built. Some cells build lime around themselves and form the bones. Some build a great network of tough fibers, called *connective tissue fibers*, which hold all the body together. Other cells make up the muscles; certain cells form organs for digesting the food; the outermost ones make for the body a tough covering which we call the skin; a great group in the head and along the back become the brain and nervous system; and still other cells become fitted for doing all the other kinds of work that must be done in the body. Thus we see that the human body, like the bodies of all living things, whether they be plants or animals, starts with a single cell; and that when the body is grown, all its parts are composed of cells, or of supporting substances, like bone or connective tissue fibers, that the cells have built.



FIGS. 15 and 16. In its first stage connective tissue is a group of cells which build around themselves a mass of jelly-like material, as shown in Fig. 15. This material hardens into the fibers that are seen between the cells in Fig. 16. All through the body a framework of connective tissue runs, holding the cells, organs, and tissues in place.

**The cells alive.** You will now understand that if you could examine with a microscope a small portion of the heart, the liver, or the brain, you would find it com-

posed of a multitude of small cells. You will understand also that each of the four hundred thousand million cells that are estimated to be in the human body is alive; that each must have food and oxygen and all the things that the body as a whole needs; that the life of the body is the sum of the life of all its cells. When we study how to keep the body in health, therefore, we are only studying how to keep the cells in health; for health means that the cells are in good condition, and sickness means that there is trouble among the delicate little parts of which the body is built.



FIGS. 17 and 18. On the right is shown a nerve cell from the brain; on the left, a muscle cell from the stomach.

**The cells bathed by lymph.** We have said that the cells of the body are built together as stones are built into a wall. You would not, however, have a correct idea of the structure of the body if you did not understand that all among our cells there are spaces and openings, and that these crevices are filled with a liquid which escapes from the blood. This liquid is called the *lymph*, and the cells are surrounded by it and bathed in it, as a fish is bathed in the water in which it swims. Only to a very limited extent is it true that we are dry-land animals; for the living parts of our bodies spend their lives under water as truly as do the fishes of the sea.

**Pure lymph necessary to the health of the cells.** If you had hundreds of small fish in a pail of water, you would be compelled to take great care in keeping the

water fresh and in feeding them, lest they should die. So with the cells crowded together as they are in our bodies, it is necessary to keep the lymph pure and clean and to supply it with the food and oxygen that the cells need. We therefore have a stomach and other organs for preparing food for the cells; we have lungs for taking in oxygen and for breathing out the waste car-

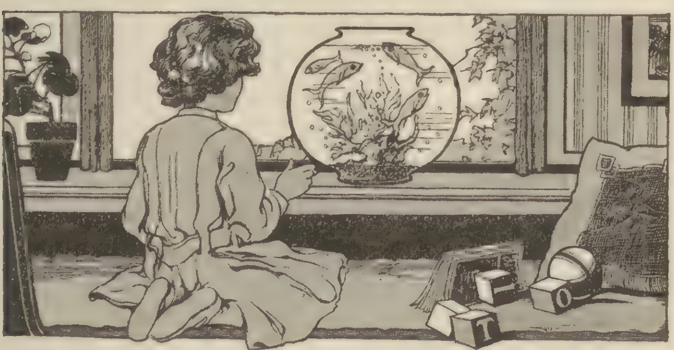



FIG. 19. As clean water is necessary for the health of the fish, so is pure lymph necessary for the health of the cells.

bon dioxid; we have kidneys for taking other poisonous wastes out of the body; and we have many other organs, each of which does its part in keeping the lymph rich and pure for the cells. When these organs do their work, our cells are like fishes living in pure, clean water where there is an abundance of food, and we are strong and well. If any organ fails in its work, either the cells will lack something that they need or the lymph in which they live will become impure, and the body will fall ill. *Pure and rich lymph is necessary for the health of the cells.*

**Keeping the human machine in repair**. From what you have now learned, you will understand that your body is a machine of many parts. You will understand also that you are in charge of this machine, and that the length of time it will last and the amount of time it will be laid up for repairs depend on the care that you give it. In this book we shall study how the body is built and how it works; for no one can care intelligently for a machine that he does not understand.

### QUESTIONS

Of what is a plant composed? Describe a cell. Where does the young plant within a seed come from? Name the parts of a flower. What is pollen? Why do bees visit flowers? What do they do for flowers? What grows from the pollen grain when it is placed on the pistil? What is fertilization? Describe the growth of the egg.

From what does the human body start? Of what are all the organs of the body built? Name some of the different kinds of cells and tissues in the body.

What do the cells of the body need in order that they may live? What is meant by health? by sickness? What fills the crevices among the cells? What is lymph? What kind of lymph is necessary to keep the cells in health? What organs prepare food for the cells? What organs take in oxygen? What organs give off wastes? What happens if any of these organs fail in their work?

### SUGGESTIONS TO THE TEACHER

If possible, secure a compound microscope and allow the pupils to examine cells. Cells scraped from the inside of the cheek or lip, or the living skin from an inner layer of an onion, may be used in demonstrating cell structure. Prepared longitudinal sections of a growing root or stem tip show not only the cells, but their differentia-

tion into tissues. Make clear the point that bone, cartilage, and connective tissue are built by the cell depositing dead materials about themselves, and that the living cells constitute only a small part of these supporting tissues.

Identify parts in a simple flower; demonstrate pollen under a microscope. The pollen grains may be made to germinate by placing them in a solution of sugar and water (a 5 per cent to 40 per cent solution, according to the kind of pollen used). Have the pupils plant sunflower seeds in pots. Select two equally vigorous plants; give one plenty of light and water, and set the other in a dark corner of the room and allow the soil to become dry. Note the difference in the appearance of the plants and call attention to the fact that the human body, like plants, is dependent on environment.

Statistics show that for each death in a community there are on an average about two years of sickness. From local vital statistics have the pupils compute how many years of sickness are annually experienced by the people of your city and state.

The economic loss from preventable disease is estimated at $16 per year for each inhabitant of the United States; compute the yearly loss to your city and state from this cause. Borrow compound interest tables from a bank and have members of the class find what sum the average American citizen would have to his credit at 20 and 60 years of age if this waste could be stopped and the money invested at 5 per cent compound interest.

# CHAPTER THREE

## THE FRAMEWORK OF THE BODY

Any one looking at the solid walls of a tall building would naturally suppose that these walls carried the weight of the great structure above them. As a matter of fact, the building has a steel framework which supports it and braces it in time of storm, and the walls do not bear even their own weight. This is shown by the fact that the workmen often finish a portion of the wall many stories above the ground, before they build in the parts that connect it with the earth. The important thing in supporting the building, therefore, is the hidden framework which outlines the shape of the building and carries its weight; it is not the walls, which are a mere covering hanging on the framework.

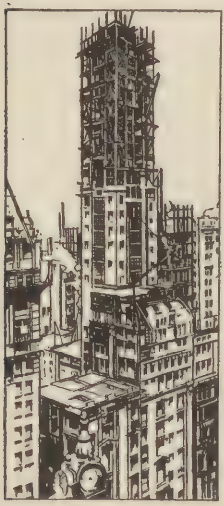


FIG. 20. The weight of the building is carried by the steel framework.

**The skeleton.** The human body, like a great building, has a framework which gives the body its shape and provides support for it. This framework is composed of 206 bones. All the bones taken together are called the *skeleton.*

In addition to supporting the body, the bones protect delicate organs like the brain and heart, and make it possible for the muscles to move the different body parts. Feel your wrists, your sides, your cheeks, or almost any part of your body, and you will find the bones under the skin and soft flesh. We shall now

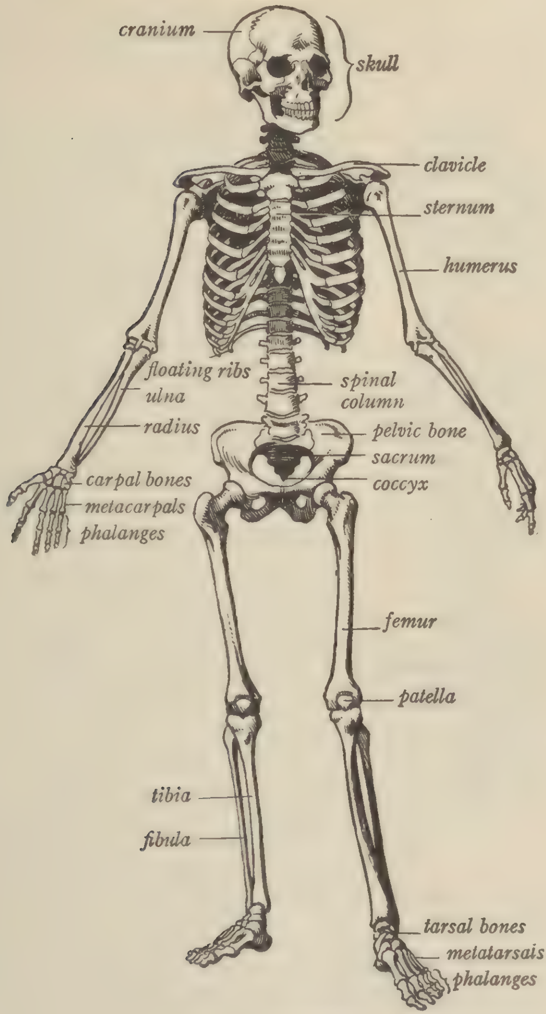



FIG. 21. The skeleton.

study the more important bones of the skeleton and the way in which these bones are joined to make a framework for the body as a whole.

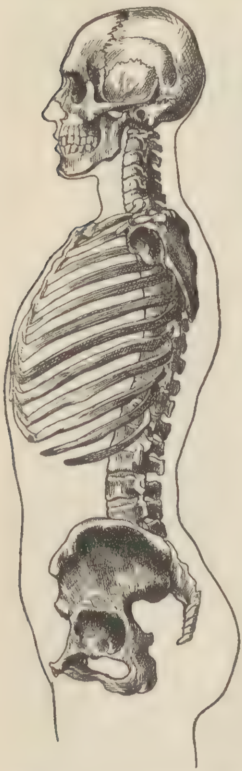


FIG. 22. The skeleton of the head and trunk.

**The spinal column the center of the skeleton.** The backbone, or *spinal column*, is the center around which the whole skeleton is built. Not only does it run up the back and stiffen and support the trunk, but it also carries the head on its top, and it has the bones of the chest and the bones of the hips attached to it. It is composed of many short bones, — an arrangement which gives it a great number of joints and enables it to bend freely and easily in any direction. Each bone of the spinal column is called a *vertebra* (plural, *vertebræ*). Five of the lower vertebræ are joined to make one large, solid bone which is called the *sacrum*. Below the sacrum there are three or four small vertebræ which form a little tail-like structure, the *coccyx*, on the end of the spinal column.

**The skull.** The skeleton of the head, or *skull*, is composed of the fourteen bones of the face and of eight bones which make a strong box (the *cranium*) to protect the brain. In the skull of a little baby there are places where the bones

have not completely covered the brain. A baby's head, therefore, needs to be protected carefully from blows.

**The ribs and sternum.** The *ribs* are twelve pairs of slender bones which curve around the chest and protect the heart and lungs. At the back they are attached to the spinal column. In front, the seven upper pairs are joined to the breast-bone, or *sternum*, and the next three pairs are hung from the ribs above. The two lower pairs have their front ends free, and are called *floating ribs*.

**The bones of the shoulder.** The shoulder has two bones, — the collar-bone, or *clavicle*, and the shoulder blade, or *scapula*. The scapula is a flat bone which lies on the back of the shoulder. It is fastened to the spinal column and ribs, and at its outer end has a socket for the head of the arm bone. The clavicle has its inner end attached to the sternum; its outer end is propped against the point of the scapula, which it supports. When the clavicle is broken, as by a fall, the shoulder drops forward and downward.

**The pelvis.** The *pelvic* or hip bones are two large, widespreading, flat bones that can easily be felt in the sides. They are firmly joined to the sacrum at the back and to each other in front. With the sacrum, these bones form the bowl-shaped *pelvis*, which gives support to the organs that lie in the lower part of the cavity of the abdomen and also furnishes a solid framework to which the legs are attached.

**The bones of the limbs.** Each limb has in it thirty bones, and the bones of the arm and leg are very similar. The thigh has in it a great bone called the *femur*, and the arm has in it a corresponding bone called the *humerus*. In the leg below the knee there are two

long bones, the *tibia* and the *fibula*, and in the forearm there are two similar bones, the *ulna* and the *radius*.

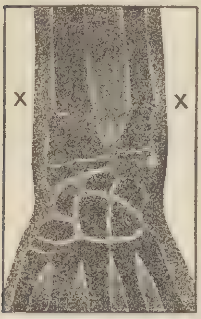



FIG. 23. From an X-ray photograph of a broken forearm and a wrist. The crosses show where the bones are broken.

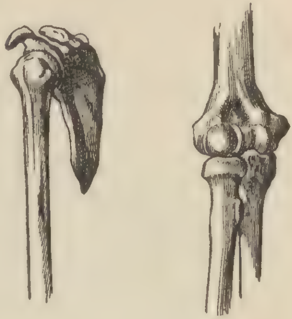
In the wrist we find a group of small bones (the *carpal* bones), and in the ankle is another group of small bones (the *tarsal* bones). In the hand are five bones (*metacarpals*), each bearing a finger, and in the foot are five bones (*metatarsals*), each bearing a toe. Finally, the fingers of each hand have in them fourteen bones (*phalanges*), and the toes have the same number of bones arranged in the same way. The arms and legs are built on the same general plan, but the wrist has one more bone than the ankle, and the elbow has no bone corresponding to the kneecap (*patella*) on the front of the knee.

**Bones composed of animal and mineral matter**. A bone is composed of animal matter and mineral matter. The mineral matter is lime. The animal matter consists chiefly of tough fibers buried in the mineral groundwork of the bone. The animal matter gives the bone its toughness and keeps it from breaking. The mineral matter stiffens it and makes it able to bear the weight of the body.

These statements you can prove for yourself by burning one bone in the fire and soaking another in a weak acid. The first bone has the animal matter burned out of it and becomes brittle like chalk. The mineral matter is eaten out of the other bone by the acid, and the bone becomes limber like a piece of rubber tubing. You can easily imagine the difficulties you would be

in if your skeleton lacked either the mineral matter which stiffens it or the animal matter which toughens it.

**Joints.** Close your hand and watch your fingers as they bend. The bending is not in the bones themselves, but at the joints between the bones, and the advantage of having a jointed skeleton is that it makes movement possible. There are two principal kinds of joints in the body, — *ball-and-socket* joints and *hinge* joints. The former allow motion freely in any direction; the latter allow motion only in two opposite directions, as does a hinge. Good examples of ball-and-socket joints are found in the shoulder and the hip; of hinge joints at the elbow, at the knee, and in the fingers.



FIGS. 24 and 25. On the left is shown the shoulder joint, an example of a ball-and-socket joint. On the right is the elbow joint, an example of a hinge joint.

**Cartilage and ligaments.** The ends of the bones at the joints are covered with a smooth, white material called *cartilage*, which is kept moist by an oil that is secreted in the joints. This keeps down friction in the joints. Around the joints are many strong bands and cords of connective tissue called *ligaments*. Their chief function is to tie the bones together, but they also inclose the joints so that the oil cannot escape.

FIG. 26. The ligaments of the wrist.

**The treatment of sprains.** When a joint is bent too far, the ligaments about it are either torn loose from the bones or broken. An injury of this kind is called a *sprain*, and a bad sprain is often more serious than a broken bone. The best way to prevent a sprained joint from becoming swollen and painful is to bathe it in hot water and to massage it, rubbing and stroking it in the right direction to send the blood and lymph back up the limb to the heart. Driving the lymph on in this way will lessen the swelling; it will take the pressure off the nerve endings and so help to relieve the pain; it will carry away the parts that die because of the breaking and tearing of the ligaments; and the fresh blood and lymph will bring a supply of oxygen and food that will hasten the building up of new ligaments.

There is a widespread idea that a sprained joint heals most rapidly when it is given complete rest, but many who are skilled in treating sprains and dislocations insist that, if the joint can be properly supported, the injured member should be used as soon as possible, even when movement causes pain. The reason given for this treatment is that exercise helps to keep up a good circulation through the part and also lessens the danger of the new ligaments being formed so short that the joint will be left stiff after the injured tissues have healed.

**Dislocations.** When a bone is thrown out of place, it is said to be dislocated. A few persons have joints so loosely tied together that a dislocation is possible with little or no injury to the ligaments, but usually in a case of dislocation the ligaments are badly torn and broken. In such a case, no one but a physician should be allowed

to try to put the bones back in place; for an unskilled person may cause much pain and do great damage by pulling and twisting at an injured limb.

**Broken bones**. When an arm or a leg is broken, it should be kept stretched out straight so that the sharp, broken ends of the bone will not cut the muscles, nerves, and blood vessels of the limb. If the person must be moved, wrap a pillow, coat, or blanket about the injured member, using sticks or something else stiff enough to keep it from bending, as shown in Figure 27. An injured person may be carried in a blanket, but a door, a cot, or other solid support is better. In lifting the person, take the greatest care to keep the injured limb from bending sharply at the break.

FIG. 27. A broken limb bandaged for moving the patient.

The two parts of a fractured bone are cemented solidly together by a jelly-like white substance which appears on the broken ends and hardens. If the broken ends are not brought together, the fracture cannot heal; and if the injured part is not properly bandaged, there is always great danger that the bone will be crooked or deformed after it has healed.

**The skeletons of old persons and of children**. The bones of old persons have very little of the living animal matter in them. They therefore break easily, and because they contain little living matter, a fracture in an old person heals very slowly or refuses to heal at all.

Old persons, therefore, should be saved as much as possible from climbing stairs and from doing other things that may cause them to fall.

In little children, on the other hand, there is a small quantity of the mineral matter in the skeleton, and the bones can easily be bent into almost any shape. During the growing years, large amounts of lime are needed for building and hardening the skeleton, and in most cases of defects and deformities of the skeleton, the trouble is caused by a lack of proper building materials or of other necessary substances in the food (pages 352, 353).

**Importance of caring for the skeleton in youth.** Heavy lifting will cause the shoulders of a child to droop forward, making him round-shouldered; making children sit with the feet hanging over the edge of a seat will cause the legs to be bowed; tight clothing may bend in the ribs and cramp the organs within the body; habitually sitting or standing in a stooped position will cause the skeleton to harden in an incorrect shape; and many persons have the face and head slightly one-sided because when they were babies they were allowed to lie on one side more than on the other. The skeleton should have especial care in youth; for after the bones have hardened, it is difficult to change their shape.

### QUESTIONS

Give three functions of the skeleton. Of how many bones is the skeleton composed? What is the function of the spinal column? What is one of the bones of the spinal column called? What is the sacrum, and of what is it composed? the coccyx? How many bones are in the skull? What is the cranium? Why should a baby's head be protected from blows?

How many ribs are there in the body? What is their use? How are they attached at the back? in front? Name and describe the two bones of the shoulder. Describe the hip bones. To what are they attached at the back? in front? How many bones are there in each limb? Name the bones of the arm. Name the bones of the leg.

Of what is a bone composed? What is the use of the animal matter? of the mineral matter? How can this be proved?

Name the two principal kinds of joints in the skeleton. Explain the kinds of movements they allow and give examples of them. What is cartilage? How is friction in the joints prevented? Give two functions of ligaments.

What is a sprain? What treatment should be given a sprain? Why? Why should a sprained joint be exercised? What is a dislocation? Why should a broken arm or leg be kept from bending? How can this be done while moving an injured person? How does a broken bone heal? Why do the bones of old persons break easily and heal with difficulty? Why are the bones of little children easily bent? What mineral should be abundantly supplied in the diet of a child? Name six things that may cause the skeleton of a child to take an incorrect shape.

### SUGGESTIONS TO THE TEACHER

Show the supporting skeleton of a leaf, using either an old leaf from which the softer tissues have fallen away, or one that has been skeletonized by boiling it in a 10 per cent potassium hydroxid ($KOH$) solution and gently scraping away the soft tissues.

Use the dry bones of animals in teaching the skeleton; decalcify the drumstick of a chicken, or any other slender bone, by soaking it in water to which acid (hydrochloric, sulfuric, or nitric) has been added. Such a bone, as well as a skeletonized leaf, may be preserved in alcohol or in a 50 per cent aqueous solution of glycerin.

# CHAPTER FOUR

## THE MUSCLES AND THE CARRIAGE OF THE BODY

It is a law of physics that a body at rest will remain at rest forever, unless some force sets it in motion by pushing or pulling on it. For example, it is the pulling and pushing of the hand that sends a thrown ball upward into the air. It is the pull of the earth that brings the ball down. It is the push of the gases that come from the explosion of the powder that sends the projectile from a great gun. It is the pressure of the steam in the cylinders of an engine that sets the machinery in motion and gives it the power to do work. Everywhere about us we see objects set in motion, and in every case this is done by a push or a pull from an outside source.

FIG. 28. The muscles.

You can lift your arms; you can extend your legs; you can move your whole body from place to place. Something must be pushing or pulling the different parts of the body to cause these movements. What is it that does this work? It is the muscles that are stretched upon the framework of the body. There are more than five hundred of these muscles, and they make up two fifths of the body weight. You are famil-

iar with the lean meat in the body of an animal, and as this is muscle, you already know something of the appearance and texture of this "master tissue" of the body.

**The structure of a muscle.** A muscle is composed of long, slender, fiber-like cells, which have the power of contracting, or shortening and thickening themselves. This action of the muscle fibers may be illustrated by allowing a stretched rubber band to come back to its natural condition; or you can get an idea of how the muscle cells change their shape by watching an earthworm shorten and thicken its body as it crawls.

The long, slender cells lie lengthwise in a muscle, and among them is a great network of connective tissue fibers, which ties the whole muscle together and attaches it to the skeleton. When the muscle fibers contract, they cause the whole muscle to shorten and thicken, as you can feel by laying your hand on your upper arm while the muscle draws itself together and lifts the forearm.

**How the muscles move the different parts of the body.** The muscles stretch across the joints of the skeleton, and when a muscle contracts, it pulls the bones together and causes a bending at the joint. Exactly how this is done you can best understand by a study of Figure 29.

FIG. 29. Showing how the muscles of the arm lift the forearm.

**Tendons.** In many parts of the body long cords of connective tissue called *tendons* attach the muscles to bones that are at a distance from them. This plan of placing muscles

at a distance from the parts that they move, keeps members like the hand from being covered with large muscles, which would be in the way when delicate work is to be done; at the same time it gives these members great strength and enables them to make many different movements.

**How the muscles move the body as a whole.** You cannot stand on a ladder and pull the ladder up after you.

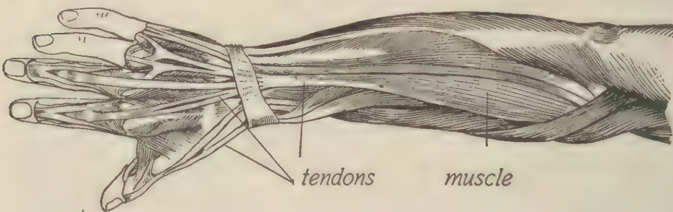



FIG. 30. The muscles of the forearm and the tendons that move the fingers.

You cannot sit on a chair and lift it. Yet you can move your whole body by muscles that are a part of your body. This is possible because you have a jointed skeleton that allows you to thrust out parts of the body and push against outside objects. How this is done you can best understand through an experiment. Stand close to the wall, place your hands against the wall, and straighten out your arms. This pushes you away from the wall and moves your whole body.

It is by this same method of pushing against something that all the different kinds of locomotion in the animal kingdom are brought about. The fish, in swimming, pushes itself forward by striking its tail and fins against the water. The bird, in flying, forces itself onward and upward by beating against the air with its

wings. In walking and running, we drive ourselves forward by pushing with the feet against the ground.

**The muscles that support the body**. Not only do the muscles move the body, but they support it when it is held erect. Muscles on the front and the back of the neck keep the head balanced on top of the spinal column. When we stand upright, other muscles hold the skeleton from bending at the ankles, knees, and hips, and at the joints of the spinal column. The most powerful muscles of the whole body are those of the back, which lie both in front of the spinal column and behind it. They are so important in the carriage of the body, that we shall study them in some detail.

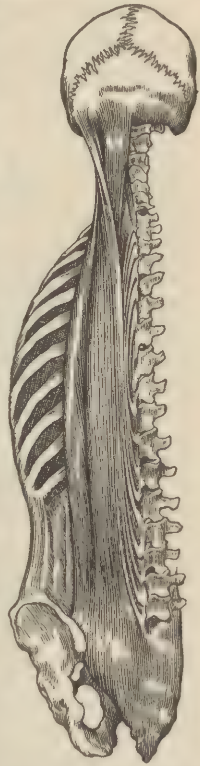


FIG. 31. The muscles that lie along the back of the spinal column.

**Muscles that support the head**. The head is held from drooping forward by muscles which rise from the vertebræ of the trunk, from the ribs, and from the bones of the shoulder; they are attached to the bones of the neck and to the back of the skull. The action of these muscles can be illustrated by attaching a string to the first joint of the finger, as is shown in Figure 32. Other muscles on the front of the neck keep the head from being drawn too far backward.

**The muscles that support the trunk**. The trunk is kept erect by muscles along the back of the spinal

column, by heavy muscles that brace the spinal column in front in the region of the waist, and by muscles in the walls of the abdomen. The action of these muscles we shall now take up separately.

The muscles along the back of the spinal column rise from the sacrum and pelvic bones and run up the back as high as the base of the neck (Fig. 31). Their function is to keep the trunk from falling forward. Their action may be illustrated by attaching a cord to the finger and drawing it down the back of the hand, as is shown in Figure 32.

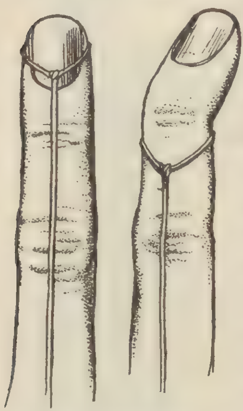


FIG. 32. Illustrating the attachment and action of the muscles that support the head and trunk.

The *abdominal muscles* are stretched between the pelvic bones and the ribs and sternum. When they contract, they draw the trunk forward and cause it to stoop, and they keep the body from being drawn over backward by the muscles of the back. By examining Figures 21 and 22, you will see how these muscles are attached and you will readily understand how they work in opposition to the muscles of the back.

The pull of the muscles along the back causes a forward curve in the spinal column at the waist. The spinal column is therefore supported in front in this region by strong muscles that brace it against the back muscles and keep it from bending too far forward. The lower ends of these muscles are attached to the femurs, which they lift in walking and running (Fig. 33).

**The body balanced over the feet in standing.** If, in standing or walking, part of the body is too far forward or backward, some other part must be thrust out in the opposite direction to keep the balance over the feet. If the head droops forward, the spinal column between the shoulders will sink backward in a balancing curve. The same effect is produced by the shoulders falling forward so that the weight of the arms pulls forward instead of downward at the sides. If the back bends inward at the waist, thrusting the abdomen forward, the upper part of the body will be bent backward, throwing the chest up in front. Each part must be held in correct position, for one part out of position is sure to force other parts out of position also. The following rules may be helpful in keeping the body in correct position in standing and walking:

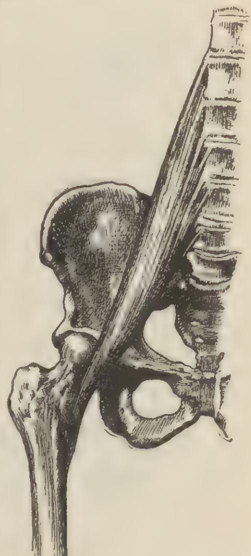


FIG. 33. View from the front of one of the muscles that keep the spinal column from bending too far forward at the waist.

*"Stand tall," thrusting up the top of the head as high as possible.*

*Walk as if you were hung by the top of your head.*

*Hold the chin close to the neck.*

*Press the back of the neck against the collar button.*

*Keep the abdomen in.*

If the upper part of the body leans too far backward, so that the heels pound in walking, *sway the body forward at the ankles until the chest is over the toes.*

*In walking turn the toes in.*

Health and vigor are most important in acquiring a correct carriage, for if the muscles that hold the body upright lie weak and slack on the skeleton, they must all the time be forced to do the work that they ought to do naturally and without effort.

**Mistakes made in trying to secure an erect carriage.** When the head droops forward, the mistake is often made of trying to bring it to an upright position by pulling the shoulders back. The true remedy is to tighten the muscles along the back of the neck and bring to an upright position the upper part of the spinal column, on which the head rests.

FIG. 34. The vertical line posture test. (*After chart supplied by courtesy of American Posture League.*)

Another mistake commonly made is to throw the head and chest back, and at the same time allow the back to be bent in at the waist and the abdomen to be thrust forward. In this case, again, the remedy is to straighten the curve in the spinal column. The muscles that lie along the front of the spinal column in the abdominal region are attached by their lower ends to the bones of the thighs, and one of the exercises that is practiced in strengthening them is to lie flat on the back and draw the legs up toward the body. Walking, running, and hill climbing also exercise and strengthen these muscles.

A third mistake often made is to try to bring the shoulders back by throwing the entire upper part of the body backward. The shoulders should be drawn back without moving any other part of the body, by pulling the scapulas flat down on the back.

**The vertical line test of posture.** One test of posture

FIGS. 35, 36, 37. The figure in the center shows correct posture; the head, neck, and trunk form one continuous vertical line. On the left, the head is too far forward, which causes the spinal column to bend backward between the shoulders and forward at the waist. On the right, the shoulders have been drawn up, the back bent inward at the waist, and the whole upper part of the body thrown too far backward. In the figures on the left and right the head, neck, and trunk form a zigzag line. (*After chart supplied by courtesy of American Posture League.*)

that is in use in many schools is called the vertical line test. If a vertical line is dropped from in front of the ear to the forward part of the foot,[1] the long axis of

[1] By forward part of the foot is meant any point from the ball of the foot back to the middle of the arch. The place where the line falls on the foot varies somewhat in different persons.

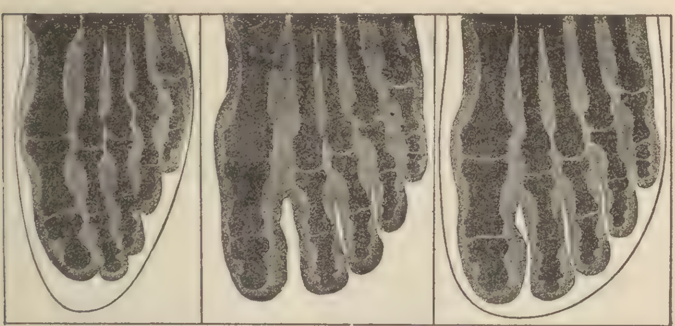
the head, neck, and trunk will, in correct standing position, be parallel to it (Fig. 34). If the position is incorrect, the line through the axis of the body will be zigzag and not a straight vertical line. The test can be made by holding a pole in the upright position, as is shown in Figure 34. The vertical line should pass just in front of the knee and in front of the shoulder.

When the trunk, head, and neck are held upright, a vertical line drawn through the middle of the tip of the shoulder should pass through the ear or behind the ear. If this line passes in front of the ear, the shoulder is too far forward.

**The foot and the carriage of the body.** Of the first million drafted men who appeared at our army cantonments in the World War, more than 175,000 had flat feet, and in 1917 more men were discharged from the service for flat feet than for any other cause, except pulmonary tuberculosis. Since deformed or painful feet make a good carriage of the body impossible, and since most foot troubles are due to shoes, we shall take up in this chapter the question of how the foot carries the body weight, and of fitting the foot with a correctly shaped shoe.

FIG. 38. The United States Army shoe. Improper shoes cause so much foot trouble that one United States Army surgeon has suggested that as a measure of military preparedness all shoes should be manufactured over lasts approved by the government. It is especially important that the feet of children be not deformed.

**The structure of the foot.** The skeleton of the foot is composed of 26 bones which are held together by muscles and ligaments.



FIGS. 39, 40, and 41. From X-ray photographs taken during investigations made by the United States Army. Figure 39 shows a foot in a shoe supposed to follow the lines of the foot, and commonly regarded as sensible. Note how the bones of the third and fourth toes are curled under, and how the great toe is bent in toward the other toes. Figure 40 shows the unshod foot of a soldier standing on one leg and bearing his 40-pound marching equipment. Note how the foot expands and lengthens under pressure. Figure 41 shows a foot in the United States Army shoe (Fig. 38). Note the free play of the toes.

Lengthwise from the heel to the ball of the foot, the bones are built together in the form of an arch. There is also a cross arch in the foot behind the toes, similar to the arch in the knuckles of a closed hand. In walking, the foot is moved through tendons that run down along the ankle from the muscles below the knee and are attached to the bones of the foot. The foot is also to a considerable extent supported and held from tipping over sidewise by the pull of these tendons from the muscles of the leg.

**Shoes that interfere with the work of the foot.** The weight of the foot falls on the heel, on the great toe and the ball of the foot behind the great toe, and along the outside of the foot behind the little toe. The foot is, therefore, a tripod, and if anything interferes with

any one of its three points of support, it becomes very unsteady.

FIGS. 42 and 43. Showing the arch of the foot, and how a high-heeled shoe props it up on end.

A high-heeled shoe props the arch of the foot up on end, instead of allowing it to stand in its natural position. Shoes with heels that slant forward move the back point of support from the heel toward the middle of the foot and make walking very insecure and difficult. Shoes with pointed toes bend the great toe outward and interfere with the inner front point of support, causing the wearer to turn the toes out and tending to cause the arch of the foot to be turned over on its inner edge.[1] Tight shoes interfere with the outer point of support of the foot by keeping the bones back of the toes from springing down and spreading apart in a natural manner and thus throwing part of the weight on the outside of the foot. All this causes tired and painful feet, and makes walking difficult and fatiguing.

[1] In the heel, the point of support is toward the outside, and the inner side of the ankle is in a great measure held up by tendons from the muscles in the calf of the leg. If for any reason the muscles of the leg are weak, the inner side of the ankle is not sufficiently supported by them and the arch of the foot is allowed to turn over on the inside. A wide, low heel built forward and out under the inner side of the ankle supports the foot at this weak point.

**The points of a good shoe.** A good shoe should have a wide, low heel, or for a natural foot, no heel at all. It should be straight along the inside so that it will not bend the great toe around toward the other toes. It should be long enough not to cramp the toes, and it should have a box in it high enough not to press on the toes and cause corns and ingrowing nails. The sole should be flat across, only slightly turned up at the toe, and wide enough that the outer border of the foot will not overhang it.

It is especially important that shoes be roomy enough to permit the feet to spread and the toes to move in walking; for if these movements are not allowed, the muscles of the feet will not develop and will lack the strength necessary to support the arches under the body weight.

**The position of the foot in standing and walking.** In walking, the feet should be carried pointing straight forward; for when the toes are turned outward, there is a tendency for the arch of the foot to be turned over so that it lies on its inner side. In standing, the toes may be turned outward somewhat, but only to a moderate degree. A person who "toes out" should practice turning his toes inward as he walks. This position of the foot is very important in securing a correct carriage of the body.

### QUESTIONS

How many muscles are there in the body? What part of the body weight is muscle?

Describe the cells of a muscle. What is the function of the connective tissue in a muscle? How does a muscle cause the skeleton to bend at a joint? What is a tendon? Of what

advantage is it to have tendons in the body? Explain how the muscles move the body in walking and in running.

What function have the muscles in addition to that of moving the body? What muscles support the head? Describe the three sets of muscles that support the trunk.

What happens if in standing or walking any part of the body is too far backward or forward? Give seven rules that may help in securing a good carriage of the body. Why is health important in securing a good carriage? Explain three mistakes that are commonly made in trying to hold the body erect. Explain how exercising the legs keeps the spinal column from bending too far forward at the waist. Explain the vertical line test of posture. Is your own posture correct by this test? What test shows when the shoulders are in correct position? How may they be pulled backward and what mistake should be avoided in attempting to do this?

How common were foot troubles among the drafted men during the recent war? How many bones are there in the foot? How are the bones held together? Where are the arches in the foot? Where are the muscles that move the feet in walking?

Why are high-heeled shoes objectionable? On what three points of the foot does the body weight fall? What is the objection to narrow heels? to heels that point forward? to shoes with pointed toes? to tight shoes? Describe a good shoe. What is the correct position for the foot in standing? in walking?

### SUGGESTIONS TO THE TEACHER

Bancroft's *The Posture of School Children* (Macmillan) will be most helpful to the teacher. The American Posture League, No. 1 Madison Avenue, New York City, issues charts and literature on posture and gives the address of manufacturers of clothing, shoes, furniture, and other articles that have been designed to meet the standards approved by the League.

# CHAPTER FIVE

## THE HEART AND THE CIRCULATION OF THE BLOOD

In New York City the street cars, automobiles, and wagons fill the streets; the elevated trains roar overhead; and deep in the earth the trains in the subway rush on and on in a procession that never ends. Nor is this all of the transportation system of the city; for water and gas are piped underneath the streets to the homes of the people; most of the wastes of the city are carried away by underground sewer pipes; and the electricity which lights the city and runs much of its machinery passes silently along wires to the places of its use. In these and in many other ways the carrying problem of the city is solved.

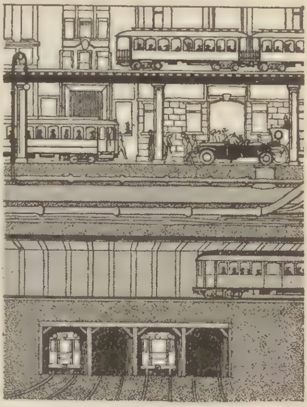


FIG. 44. Transportation in New York City.

**The carrying problem in the body.** As a city is composed of a multitude of people, so is the body composed of a multitude of cells — 400,000,000,000, according to one estimate. Each of these cells must have food and oxygen, and each must get rid of its wastes. There must, therefore, be a transportation system in the body, and it must be one that is always in working order — not one that breaks down and fails in its work from time to time. Transportation by water is more reliable than any other method that has yet been devised, and this is the method we find used in the body.

**The carrying in the body done by the blood.** All through the body there is a great system of tubes, or pipes, called *blood vessels.* Night and day the heart pumps the blood through these vessels. Everything that the cells need is dissolved in the blood and carried to them in the blood stream. Into this stream each cell gives off its wastes to be carried away. *Thus all the carrying within the body is done by the blood, and the blood is kept in constant motion through the body by the heart.*

**Arteries and veins.** The blood in its movement, or *circulation*, through the body flows through the same channels again and again, always returning to the starting point, the heart. We have, therefore, two sets of blood vessels in the body, — the *arteries*, which carry the blood *from* the heart, and the *veins*, which bring the blood *to* the heart. The large arteries which leave the heart send branches to the different parts of the body. These branches divide into finer and finer branches, called *capillaries*, which run in among all the cells. Then the capillaries unite into small veins. The veins, like the creeks that form a river, keep coming together, until finally all of them are united into the great veins which carry the blood back to the heart.

To understand how the blood passes from an artery into a vein, think of two trees standing with their trunks close together and their tops touching each other. Then imagine that the blood flows up the trunk of one tree, out into its branches and twigs, then on into the twigs and branches of the other tree, and down its trunk. If the blood should make a circuit of this kind through the trees, its journey would be like the one that it makes

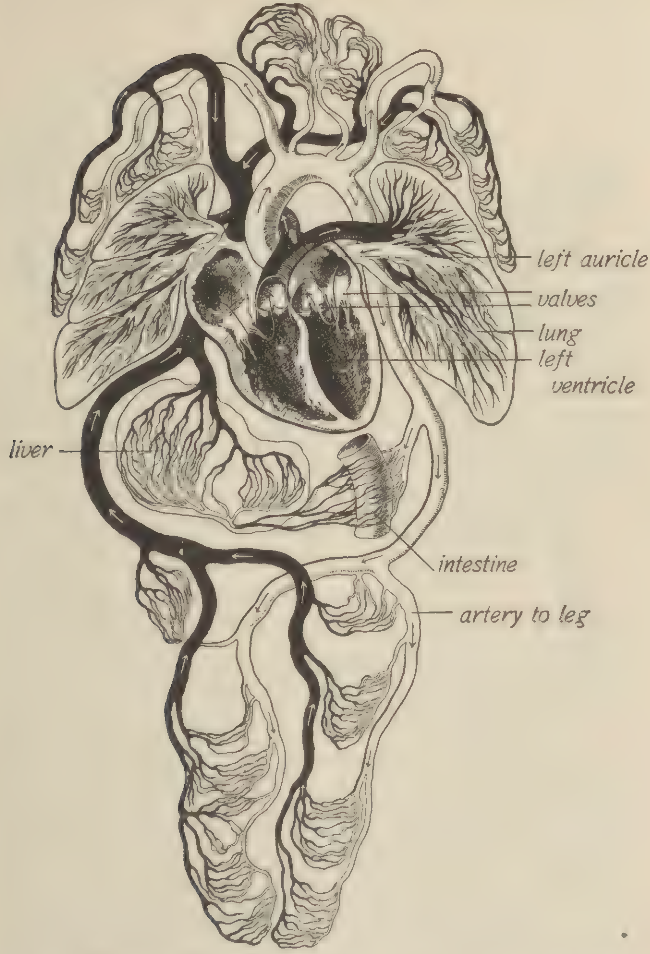



FIG. 45. Diagram showing the circulation of the blood. Note the valves between the auricles and ventricles and at the mouths of the great arteries that open out of the ventricles.

when it passes out from the heart through an artery and returns to the heart through a vein.

**The heart**. The heart lies in the chest with its point to the left of the center. Its walls are made of strong muscles, and within the heart are four chambers, or cavities, two on each side. The two upper cavities are called *auricles;* the two lower cavities are called *ventricles*.

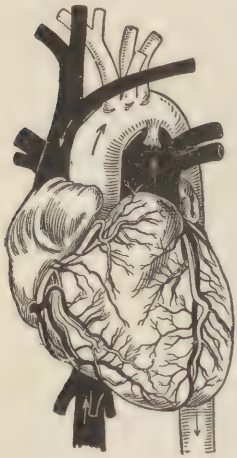


FIG. 46. The heart.

**The action of the heart.** The veins pour the blood into the auricles. Then the walls of the auricles contract and force the blood down into the ventricles. Next, the strong walls of the ventricles close in on the blood, and drive it out into the arteries and all through the body. After forcing the blood into the arteries, the walls of the ventricles relax, and for a moment the heart rests. Then again the auricles, contracting on the blood that has flowed in from the veins, fill the ventricles, and the ventricles pump the blood on into the arteries. Place your hand on the left side of your chest, and you will feel your heart move as its walls close in on the blood and force it onward through the vessels.

**The valves of the heart.** In every pump there must be valves to keep the liquid from flowing backward. The heart, like other pumps, is provided with these valves, — two between the auricles and the ventricles, and two at the mouths of the arteries to keep the blood

from flowing backward into the ventricles when their walls relax and the chambers open after each beat. In

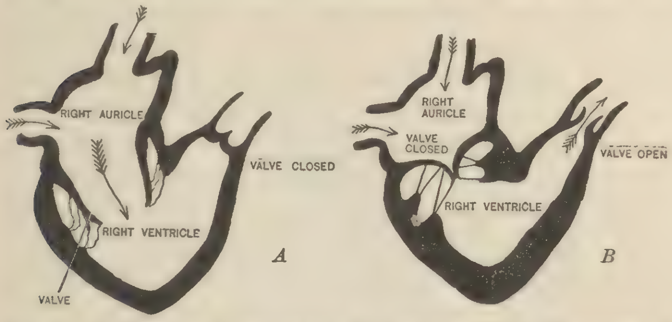



FIG. 47. A diagram of the right side of the heart showing the working of the valves. When the blood flows into the auricles and the ventricles relax, the valves of the heart are as shown in *A*. When the ventricles contract and the blood flows out into the arteries, the valves are as shown in *B*.

Figure 45 you can study out where the valves are placed, and from Figure 47 you can understand how they prevent a backward flow of the blood in the vessels and in the heart.

**Tracing the circulation of the blood.** Trace the circulation of the blood in Figure 45, and you will see that the heart is a double organ; that the right side sends the blood on a short journey through the lungs and back to the left side; and that the left side drives the blood into the arteries for a long journey through all the body and back again to the right side of the heart. The blood flows through the vessels very swiftly, making the journey through the lungs in about fifteen seconds, and the long journey through the body in less than a minute.

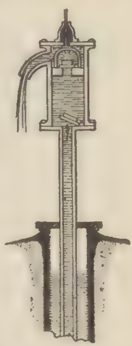


FIG. 48. A diagram of a pump. Locate the valves and explain how they work.

**The blood composed of plasma and corpuscles.** The blood is composed of a liquid part called *plasma*, and of millions of little cells called *corpuscles*, which float in the plasma. About nine tenths of the plasma is water. The remainder is composed of dissolved food and other materials that are needed by the cells, and of the wastes that come from the cells. The corpuscles are of two kinds, the *red* and the *white*. The red corpuscles are so abundant that there are millions of them in the smallest drop of blood. It is the red corpuscles that give the red color to the blood.

FIG. 49. Red blood corpuscles (*A*) and white blood corpuscles (*B*).

**The function of the corpuscles.** As the blood passes through the lungs, it takes oxygen from the air that is breathed into the lungs. The oxygen is then carried through all the body and given up to the cells. *This carrying of the oxygen is done by the red corpuscles.* Like little boats floating in the blood stream, they take up their loads of oxygen in the lungs, carry the oxygen out through the body, unload it for the hungry cells, and hasten back to the lungs for more of the oxygen which the cells must have. The importance of this work is shown by the fact that when the heart ceases to beat, or when a person is under water so that the oxygen is cut off from the lungs, the life of the body quickly comes to an end.

The white corpuscles are larger than the red ones and are fewer in number. *Their work is to kill the disease*

*germs that get into the body.* This subject we shall discuss in a later chapter (page 449).

**The lymph.** The blood capillaries are so small and so abundant among the cells that you cannot stick a pin into your tissues anywhere without breaking many of them and letting the blood escape. The capillaries have very thin walls, and as the blood flows through them some of the plasma escapes and passes out into the spaces among the cells. This escaped plasma is the lymph, about which you have already studied in the chapter on the cells (pages 224 and 225).

FIG. 50. The cells are bathed in lymph, which is plasma that escapes through the thin walls of the small blood vessels. (Diagrammatic.)

**The lymph a middleman between the cells and the blood.** In Figure 50 you can see how the cells lie among the capillaries, and how they are bathed in the lymph that escapes through the thin walls of these vessels. The cells, therefore, are not in the blood stream, but this stream, so to speak, merely passes by the house, and the cells must find some way of getting their supplies from the stream into the house. This is done through the lymph. As the red corpuscles pass along in the capillaries, the

oxygen breaks loose from the corpuscles, passes out through the walls of the vessels into the lymph, and so reaches the cells. In the same way, the foods that are dissolved in the plasma make their way out into the lymph that surrounds the cells, and the wastes that the cells give off pass through the lymph into the blood and are carried away. *The lymph acts as a middleman between the cells and the blood, passing the oxygen and food from the blood to the cells, and the wastes from the cells to the blood.*

**The lymphatic vessels.** Among the cells of the body there is, besides the blood capillaries, a system of fine, thin-walled lymphatic capillaries. These unite and form larger vessels, which finally empty into the veins of the shoulders. *The lymphatic vessels act as a drainage system for the body, and their function is to gather up and drain off the stale, impure lymph from among the cells and empty it into the blood.* This allows fresh lymph to escape among the cells, bringing with it supplies of food and oxygen. The lymphatic vessels of the greater part of the body unite in one great vessel called the *thoracic duct.* This runs up the back of the cavities of the abdomen and chest, and empties into the large vein in the left shoulder.

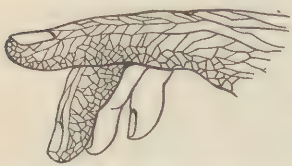


FIG. 51. Lymphatic vessels in the fingers.

**The importance of caring for the heart.** The responsibility of keeping the whole transportation system of the body in operation falls on the heart, which is usually about the size of the fist of the person to whom it be-

longs. Night and day, from birth until death, this little organ pumps away, giving a stroke oftener than once a second. We cannot replace an injured valve in it with a new one; it could not stop long enough for that, even if we knew how to do it. If it becomes overworked, or if it is poisoned by disease germs, there is no second pump to take its place while it rests and gets into good condition again. It is such a wonderful organ that usually it gives us little cause for complaint; yet there are certain things that injure the heart, and for our own good we ought to know of these things and avoid them. We shall therefore mention at this time some of the points that are important in the care of the heart.

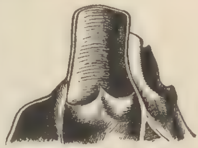


FIG. 52. Valves in an artery where it leaves the heart. There are three valves attached like loose pockets to the wall of the artery. When the blood starts to flow backward into the heart, it catches in the pockets, which then swing out and close the opening into the heart.

**The heart injured by disease germs.** By far the most common cause of trouble in the heart is disease germs. In diphtheria and scarlet fever the nerves and the muscle cells of the heart are so damaged by the poisons produced by the germs, that even in the mildest cases of these diseases, physicians frequently forbid the patient to sit up in bed, because they fear the effect of the strain on the heart. Furthermore, the heart is often so poisoned by an attack of one of these diseases that the nerves and muscle cells never recover, and the heart is left weak for life. In other diseases, such as pneumonia, rheumatism, and influenza, the germs themselves attack the valves and cause them to shrivel and harden, so that they allow the blood to leak back-

ward, and again the heart is damaged for life. As much as possible, therefore, we ought to avoid all these germ diseases, — the catching diseases which are so common, and which people often carelessly give to each other. After an attack of one of these diseases, hard exercise should be avoided until the heart has had time to regain its strength.

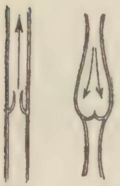


FIG. 53. A valve in a vein. The veins have valves in them to prevent the blood from flowing backward when pressure comes on the veins. Run your finger down a vein on your forearm, and little knots will stand out on the vein at the points where the valves are located.

**Too much exercise injurious to the heart.** When the muscles are working, they need more food and oxygen and give off more wastes than when they are at rest. The heart must therefore pump the blood more swiftly through the body when we use the muscles. This you can prove for yourself by noting how much harder and faster your heart beats after running or after doing other hard work. Indeed, when we take hard and long-continued exercise, it is usually the heart that becomes tired first of all, although we may not feel it.

There is danger, therefore, of overworking the heart, especially at that time of life when the boy or girl is entering manhood or womanhood and the body rapidly increases in size. When overworked, the heart, like any other muscle, at first enlarges, and then, if the overworking is kept up, becomes weak and flabby. This condition of the heart is called "athletic heart." If a person whose heart has been injured by overexercise takes a long rest, going to bed, if necessary, his heart usually recovers. He ought, however, to take care not to force his heart into this condition.

**Proper and improper exercise.** Do not keep on at any heavy work or hard game until you are exhausted. Do not play tennis all day. Do not spend a whole Saturday afternoon playing football. Remember that a baseball pitcher needs a stout heart as well as a strong arm, and that, for the sake of both your arm and your heart, you should not stay in the pitcher's box a whole half-day at a time. Do not enter long Marathon races that are intended for men and not for boys, and do not get on your bicycle and ride at a fast pace, hour after hour, up hill and down. You should understand, however, that it is only *overwork* that you are being cautioned against, and that both moderate exercise and severe exercise taken for short periods, are beneficial to the heart, as well as to other parts of the body.

**Tobacco injurious to the heart.** Tobacco sometimes damages the heart until it has a quick, weak, and fluttery beat. This is a serious ailment, but usually, if the tobacco is given up, the heart seems in time to recover. Coaches and trainers will not allow athletes to smoke, because smoking weakens both the heart and the other muscles. The question of the effects of tobacco on the body we shall discuss in more detail in a later chapter (page 409).

**The heart injured by headache remedies.** A number of drugs commonly used (among them phenacetin, acetanilid, and antipyrin) will check a headache. The practice of taking these drugs for headaches and colds is dangerous; for they all weaken the action of the heart, and their continued use will bring on heart disease. They should be taken only when prescribed by a physician, and no good physician will prescribe them often

for the same person; for treating a headache in this way is not finding and removing the cause of the trouble, but drugging the body so that the pain will not be felt.

**The effects of alcohol on the heart and blood vessels.** Alcohol causes the walls of the blood vessels to become weak and brittle. For this reason, apoplexy, which is caused by the bursting of a blood vessel in the brain, is more common among users of alcohol than among abstainers. Alcohol often weakens the heart by causing its muscle cells to change to fat. In many beer drinkers there is the additional trouble that the working cells of the heart are buried in a great mass of fat that must be lifted and moved every time the heart beats. When one realizes that in germ diseases everything depends on the heart's keeping at work until the body has had time to overcome the germs that are attacking it, the disastrous effects of alcohol are more easily understood. In pneumonia, especially, when it is a great task for the heart to drive the blood through the congested lungs, and in diseases in which the heart is weakened by the poisons from the germs, it is most important that the full power of this organ be saved for the ordeal which it must undergo. Statistics from a hospital in a city where excessive beer drinking is very common, show that 16 per cent of all deaths in the hospital were due to "beer-drinker's heart."

**Digestive troubles and the heart.** When the digestive organs are out of order, the stomach sometimes becomes filled with gas and presses on the heart, causing a most uncomfortable feeling and a pounding and irregular beating. The digestive system, of course, should be

given proper treatment in cases of this kind, but if this is done, there need be no alarm about the heart itself.

### QUESTIONS

What must be carried to the cells and away from them? How is this carrying done? What is the movement of the blood through the body called? What is an artery? What is a vein? What is a capillary? How does the blood pass from an artery into a vein?

Describe the heart. Explain how the heart forces the blood through the body. Where are the valves in the heart and what is their use? Trace the circulation of the blood from the right auricle back again to the right auricle.

Of what is the blood composed? Of what is the plasma composed? What is the function of the red corpuscles? of the white corpuscles? What is the source of the lymph? Explain how the lymph acts as a middleman between the cells and the blood. Describe the lymphatic vessels. What is their function? What and where is the thoracic duct?

Why is the care of the heart so important? What is the most common cause of injury to the heart? How does overexercise affect the heart? At what age is the heart especially likely to be injured by overexercise? Name some games that put a great strain on the heart.

What effect has tobacco on the heart? Name some drugs that are commonly used as headache remedies. What effect have these drugs on the heart? How do they relieve a headache? What effect has alcohol on the blood vessels? What causes of death are especially common among drinkers on account of this effect of alcohol on the vessels? What effect has alcohol on the heart? When is the bad effect of alcohol on the heart especially likely to show itself? What effect does indigestion sometimes have on the heart?

## SUGGESTIONS TO THE TEACHER

If possible, secure a glass model of a pump, such as is commonly found among the equipment of an elementary physical laboratory, and demonstrate the action of the valves. Allow the pupils to examine a drop of blood under the microscope. Additional matter on the topics discussed in this chapter and in many of the other chapters in this book will be found in *Human Physiology*, the most advanced book of the series.

An examination of the diagram on page 445 will show that heart disease is one of the great causes of death. It is now generally accepted that practically all cases of heart disease (as well as cases of rheumatism, Bright's disease, and disease of the arteries) are caused by germs. Usually these germs are slow-growing races of streptococci, and often they have a permanent breeding ground in the tonsils, at the roots of teeth, in the bones of the face, or in some other part of the body, and are carried from these "foci of infection" to the heart and other organs. In overcoming these slow infections, a hygienic life is of great importance, but treatment of the teeth or other infected part is often necessary. The relation of these chronic infections to the general health should be brought to the attention of the class during the study of later chapters.

# CHAPTER SIX

## RESPIRATION

FILL a bottle with boiled water and one with unboiled water, and arrange growing beans in them, as is shown in Figure 54. The bean with its roots in unboiled water will grow for a considerable time — as long as the mineral matter in the water will provide it with food materials. The roots of the plant in the boiled water will quickly die and the whole plant will then wither, because the roots no longer send the water up to the leaves.

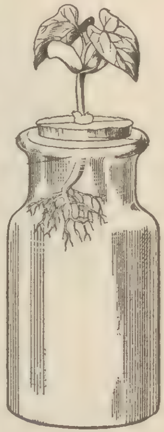


FIG. 54.

Why is it that the roots in the boiled water die? The answer is simple. The boiling of the water drives the oxygen out of it, and without oxygen the cells of neither plants nor animals can remain alive.

**The object of respiration.** *The first object of respiration is to take oxygen into the body.* Of food, we have enough stored in the body to maintain life for a number of days, or, in some cases, even for several weeks. As to oxygen, however, the body leads a hand-to-mouth existence; for though the air is more than one fifth oxygen, there is not enough of this gas in the body to keep us alive for more than two or three minutes after breathing has stopped. While we sleep, therefore, we must keep on breathing in oxygen; sit as quiet as we may, we must still keep on taking it in; and when we walk or run, we do it taking in oxygen as we go.

*The second object of respiration is to give off carbon*

*dioxid from the body.* Carbon dioxid is a waste gas that is all the time being formed in the cells and carried by the blood to the lungs, to be breathed out into the air. It is formed not only in the body, but where wood, coal, oil, or gas is burned, and it is sometimes found in coal mines, where it is known to the miners as "choke damp."

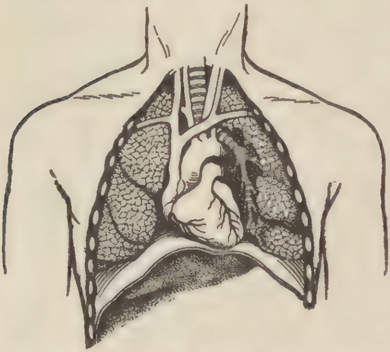


FIG. 55. The chest, showing the position of the heart and lungs.

**The cavity of the chest.** The cavity of the chest contains the heart and the *lungs*. This cavity is inclosed by the ribs and sternum, and is separated from the abdominal cavity below by a thin cross-partition called the *diaphragm*. In breathing, the chest cavity is enlarged by lifting the ribs upward and outward, and by pulling the diaphragm downward.

**The trachea and the lungs.** The *trachea* has in its walls stiff rings of cartilage that hold it open so that the air can pass freely through it to and from the lungs. At its base the trachea divides and sends a great branch to each lung. Within the lungs these branches divide again and again, until finally they end in little, thin-walled air sacs. The branches of the trachea are called the *bronchial tubes*, and the lungs have a light, spongy texture because they are composed chiefly of these tubes and of the air sacs in which the tubes end.

**The changes in the air in the lungs.** The walls of the

air sacs are very thin, and great numbers of small blood streams constantly flow through the capillaries in them. The oxygen of the air that we take into the lungs passes into the blood through the walls of the sacs, and

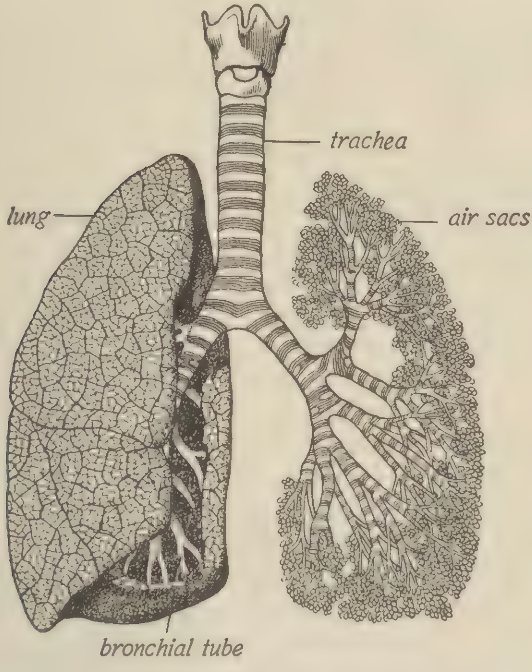



FIG. 56. The lungs.

the carbon dioxid that is in the blood passes out into the air that is in the sacs, and is then breathed out of the lungs. *The air in the lungs, therefore, loses oxygen and gains carbon dioxid, and the blood takes in oxygen and gives up its carbon dioxid.*

These changes take place very rapidly in the lungs, for the capillaries are so numerous that they cover more than one third of the surface of the air sacs, and all the blood in the body goes through them in a little over a minute.

FIG. 57. A small bronchial tube and the air sacs in which it ends.

**Injury done to the respiratory organs by dust.** Nearly all the diseases of the air passages and lungs are caused by germs. Dust wounds and injures the delicate lining of these parts, and makes it easy for germs to gain an entrance into the tissues. The majority of workmen in certain industries, such as metal grinders, potters, and workers in cotton and woolen mills, die of pneumonia, tuberculosis, and other respiratory diseases. This is due to the multitude of tiny wounds continually being made in the walls of the air passages by the sharp dust and fine fibers with which the air of many factories and mills is laden. Much can be done to make dusty trades more healthful by using water in operations where dust is formed, by hoods and air blasts that suck up the dust from machines, and by the workmen wearing appliances to protect themselves from the dust.

FIG. 58. A workman wearing a mouthpiece to protect himself from dust. (*From a photograph by the Massachusetts State Board of Health.*)

**Sweeping without raising a dust.** In many states

dry sweeping of school buildings and of other public buildings is forbidden by law, because it stirs up great quantities of dust, which then remains floating in the air for hours. The best method of cleaning public buildings, as well as private homes, is the vacuum process. When this cannot be used, wet sawdust, a sweeping compound, or something else effective should be employed to keep down the dust. One device that is sometimes used is a can attached to the handle of a broom and so arranged that it keeps the broom moist with kerosene or water. The floor brush shown in Figure 59 is very satisfactory for sweeping, and paraffin oil is extensively used in making up floor dressings and sweeping compounds. This oil may be purchased for ten cents a quart, or at a lower price in larger quantities, and it gives an excellent polish to floors and furniture. Sawdust moistened with it makes a very satisfactory sweeping compound, and a cloth dampened with it is the best thing for removing dust from furniture and for cleaning doors.

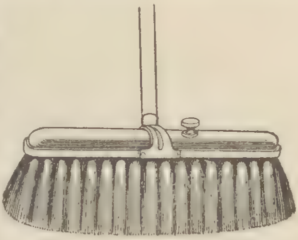


FIG. 59. A dustless brush. The back of the brush is hollow and is filled with kerosene, which slowly trickles down and keeps the bristles moist while the sweeping is being done.

**Gaseous impurities in the air.** In many houses small quantities of gas are constantly escaping from the pipes, and often this leaking of gas is allowed to run on for weeks and months before the pipes are repaired. Breathing this gas, especially if it is water gas, is most injurious to the health. Another most harmful practice is the use of gas and oil stoves that have no pipes to

carry away the fumes; for it is ruinous to the health to breathe the poisonous gases that come from them.

**The effect of tobacco on the respiratory organs.** Tobacco smoke is hot and irritating and often causes sore tongue and "smoker's sore throat." Undoubtedly these diseases sometimes lead to cancer, because any part of the tissues that is constantly irritated may develop into a cancer. When the smoke is inhaled into the lungs a sooty deposit which must certainly be injurious is left on the walls of the bronchial tubes.[1] When smoke is exhaled through the nose it has a tendency to cause catarrh and injures the sense of smell. The nicotin that is taken into the blood, either by partially paralyzing the nerve centers that control the breathing muscles, or by its effect on the muscles themselves, causes the shortness of breath with which every smoker who has tried to take part in athletic sports is familiar.

### QUESTIONS

Why will a plant die if its roots are in boiled water? What is the first object of respiration? Why can a person live a long time without eating, but only a few minutes without breathing? What is the second object of respiration?

What organs are in the cavity of the chest? By what is the chest inclosed? How is the chest cavity enlarged in breathing? Describe the trachea and its branches. How do the bronchial tubes end? Explain the changes that take place in the air in the lungs.

[1] "Surely smoke becomes a kitchen far better than a dining chamber, and yet it makes a kitchen oftentime in the inward parts of man, soyling and infecting them with an oyly kind of soote as hath been found in some great tobacco takers, that after their death were opened." — KING JAMES I.

Why is breathing dust dangerous? What may be done to keep down dust in factories? How may buildings be swept without raising a dust? Why should leaks in gas pipes in houses be carefully looked after? Why is it injurious to use gas or oil stoves that have no pipes to carry away the gases?

## SUGGESTIONS TO THE TEACHER

Have a pupil breathe through a glass tube into limewater. The white precipitate is calcium carbonate, which is formed by the union of the carbon dioxid with the calcium in the limewater.

Call attention to the dust particles which may be seen floating in the air when a beam of sunlight penetrates a darkened room. Use all possible influence to have the school building swept and dusted in a sanitary manner. Call attention to the importance of hygienic industrial conditions and to the fact that, in selecting an occupation, the effect of the work on the health is as deserving of consideration as the wages that may be earned.

# CHAPTER SEVEN

## VENTILATION

FIG. 60. Move your bed out into the open air if it is possible for you to do so.

IN 1758, during a rebellion of the native soldiers in India, one hundred and forty-six Englishmen were shut up overnight in a room that had but a single window. When morning came, only twenty-three of them remained alive. After the battle of Austerlitz, three hundred prisoners were crowded into a cavern. In a few hours two thirds of them were dead. Many other instances are on record of people who have perished when shut up in closets, vaults, or the holds of ships. Most persons have read of some of these instances, and practically every one takes care to keep out of places where he is likely to perish because his supply of air fails.

It would seem, however, that many persons are like the kind-hearted old gentleman who could not bring himself to cut his dog's tail off all at once, and so cut off an inch each morning until the tail was gone; for while these people object most decidedly to killing their bodies all at once with bad air, they do not seem to mind killing them a little at a time. Perhaps they do not realize what they are really doing, but the damage is constantly being done, nevertheless; for they go to churches, lecture halls, and theaters where the air is so foul that it gives them headaches; many persons sleep in rooms with windows and doors so tightly closed that the sleepers must breathe the same air again and again; children often cover their heads with the bedclothes and do not get a breath of fresh air all night long; and many schools and factories are so badly ventilated that the health and the working power of those in them are continually being undermined. The whole subject of ventilation is, therefore, of the very greatest importance, and in this chapter we shall take up the study of why we need fresh air and how to get it.

**Enough oxygen usually in the air.** About one fifth (21 per cent) of the air is oxygen, and the remainder is nearly all nitrogen. The nitrogen is not used in the body, but is simply breathed into the lungs and breathed out again unchanged. The oxygen is taken into the blood and carried through the body to the cells. Air that has been breathed once has lost about one fourth of its oxygen, and where people are crowded together as the English were in the "Black Hole of Calcutta," the oxygen in the air becomes exhausted. We can live,

however, on 15 or even on 12 per cent of oxygen, and under any ordinary conditions the trouble with the air we breathe is not with the amount of oxygen in it.

**The carbon dioxid problem.** Carbon dioxid is given off into the air from the lungs, and too much of it in

FIG. 61. An outdoor lesson in geography. (*After Ayres.*)

the air is poisonous to us. It was long supposed that this was the chief trouble with indoor air, — that the paleness and lack of strength noticed in those who lived without good ventilation were due to carbon dioxid poisoning. All our rules for ventilating buildings have been laid down with the idea that we must bring in large quantities of fresh air (3000 cubic feet per hour for each person) to keep the carbon dioxid from becoming too abundant in the air that we breathe. This is still a good rule to follow; for it has not yet been proved that breathing large amounts of carbon dioxid week after week is not injurious to the health. Recently, however, it has been proved that in ventilation

other questions besides the amount of carbon dioxid in the air must be considered.

**Dry air injurious.** In rooms heated by stoves, radiators, or hot-air systems, the atmosphere becomes too dry, unless special arrangements are made for moistening it, — drier, in fact, than is the air in the Desert of Sahara. Since dry air quickly evaporates the sweat from the skin and cools the body, people often heat such rooms up to 75 or 80 degrees, because they feel cold at lower temperatures.

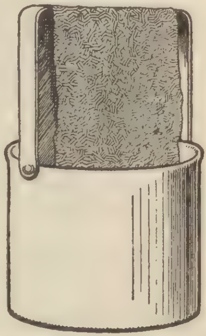


FIG. 62. A home-made humidifier — a pail with a strip of cloth arranged for feeding the water up and letting it evaporate into the air.

Living in a hot, dry atmosphere of this kind is injurious to the eyes, and it makes people subject to colds; it causes nervousness, also, and a child in a dry, overheated schoolroom is restless and has difficulty in keeping his mind on his work. Vessels of water should therefore be kept in furnaces and on stoves and radiators; and in school buildings heated with hot air, arrangements should be made to moisten the air before it is discharged into the rooms. It is economy to give attention to this point; for moist air feels as warm at 65 degrees as dry air at 75 degrees; in some school buildings as much as a 10 per cent saving in fuel has followed the installation of devices for moistening the air.

**A moist atmosphere and overheating.** When the temperature of moist air rises much above 70 degrees, it gives us a hot, suffocating feeling, similar to that

which one has on a warm, sultry summer morning. The explanation of this is that the moisture in the air keeps the sweat from evaporating, and there is a layer of hot, wet air surrounding the body like a shell. In crowded buildings, therefore, where the air is wet from many people breathing it, a proper temperature is very important. It ought not to fall below 65 degrees, for then the people will be chilly; and it ought not to run above 70 degrees, for then the people will become hot and uncomfortable, some of them will develop headaches, and many of them will catch cold when they step out into the cool outside air.

**The necessity for motion in the air.** In hot weather, and in warm and wet indoor atmospheres, it is most important that there be air currents to break up and blow away the hot, moist air blankets that surround us. How important such air currents are, is shown by an experiment that was carried out in England. In this experiment, a group of students were closed in a small room and watched through a glass in the door. At first they were laughing and joking, but soon they began to show signs of distress. Formerly it would have been concluded that they were suffering from a lack of oxygen or were being poisoned by carbon dioxid. The real trouble, however, was the overheating and the moisture in the air, as was proved by the fact that when an electric fan was started in the room, the students became comfortable again without the introduction of fresh air.

**Setting indoor air in motion.** In public buildings the air often becomes close and the temperature rises after meetings have been in progress for some time. In such

cases a great deal can be done towards keeping the audience comfortable by opening a few windows, so that part of the heated air will escape and currents will be set up through the building. In the Chicago schools, every window in every schoolroom is thrown wide open three times a day to allow the wind to sweep out the stale air in the buildings and to break up and blow away the envelopes of moist air from about the bodies of the pupils. Practices like this should be followed everywhere. A few minutes devoted to flushing out a schoolroom and going through a few resting and stretching exercises are by no means to be counted as lost, for the pupils return to their work with new vigor and zeal.

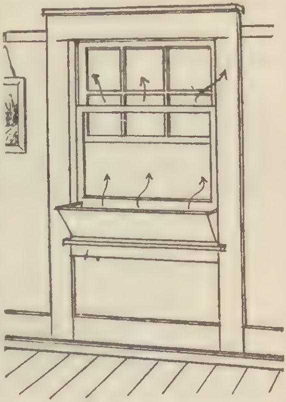


FIG. 63. A window board helps to ventilate a room.

It is well to understand also that the health of many workers could be improved and their working power greatly increased by providing them with electric fans during the hot summer weather. Many factory owners who have put in ventilating systems have found that the increased amount of work accomplished by the laborers in the factory far more than paid the cost of putting in and operating the system. This is what we should expect, for every one knows the difficulty of working in an overheated, stifling atmosphere, and how bracing and invigorating a current of air is on a hot, oppressive day.

**Disagreeable odors in crowded rooms.** In crowded and heated rooms, odors always arise that cause headache and a feeling of faintness in persons who are sensitive to them. A low temperature makes these odors much less noticeable, and a current of fresh air through the room not only sweeps away the odors themselves, but also refreshes the people and destroys the effects of the odors on them. Persons who are troubled with symptoms of illness when they attend public meetings can sometimes escape the difficulty by arranging for a seat near a ventilator or window, or where a current of air from an open doorway will blow across them. It is probable that "crowd poisoning" is nothing but the effect of the overheating and of the odors that are usual in buildings where many people are assembled.

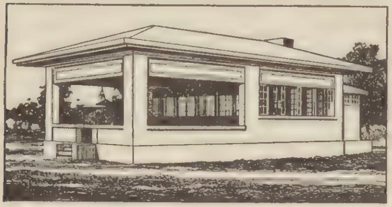


FIG. 64. An open-air schoolroom in Sacramento, California. The inclosed room is used only in bad weather.

**Open-air schools.** In Oakland, California, during the winter of 1910–1911, an open-air school was in operation. In this school the children did regular work, and they had no special feeding or rest periods. Yet during the first half year no child in the school failed to gain in weight, and the average gain was 3.70 pounds; in the regular school building the average gain was 2.36 pounds. The children in the open-air school were free from colds, while, as usual, the children in the indoor school at times suffered from them. Most noticeable of all, however,

was the wide-awake, energetic way in which the open-air pupils kept at their work. Day after day they finished their tasks without becoming tired, and by the end of the year all of them had advanced one grade, several of

FIG. 65. An outdoor classroom at Williamsburg, Virginia. When the children become tired indoors, classes are taken to this building for a recitation. There were only 20 days during the winter of 1911–1912 on which this outdoor classroom was not used.

them had advanced two grades, and one boy had done two and one half years' work in the one year.

In many places open-air schools have been established for sick children, with the idea of nursing them back to health rather than of advancing them in their school work. In these schools the pupils are fed and have long rest periods, and only light school work is done. Experience has shown, however, that in the open air the children throw themselves into the work so eagerly and their minds are so clear that even in outdoor schools that give only half the usual time to study, the pupils advance as rapidly as they do in an indoor school where they spend the whole day over their books.

Why, then, should not boys and girls who are in good health, as well as those who are sick, be in schools where they can master their work with the greatest ease and at the same time build up their bodies by breathing outdoor air? The time has come when each community must answer this question. In mild climates and in warm weather, there is certainly no reason for going to the great expense of trying to get the right kind of air indoors, when nature has filled all outdoors with exactly the kind of invigorating air that we need.

FIG. 66. Open-air classes held on the roof of the Horace Mann Elementary School, Teachers College, New York.

**Outdoor sleeping**. In recent years thousands of outdoor sleeping porches have been built in our country. Without a doubt the health is greatly benefited by passing in the open air the many hours that we spend in sleep. The only point that needs to be remembered in moving outdoors is that the warmth of the body must be kept up; that man moved into houses to protect himself from the cold and wet, and when he moves out of them again he must have clothing that will keep him warm and dry. If this point is looked after, the more time we spend outdoors the better. Therefore, move out into the outdoor air to sleep if you can, and if you cannot do this, open wide the windows of your bedroom and let the outdoor air come to you.

### QUESTIONS

What two gases make up the greater part of the air? Which of these gases is used by the body? Under what conditions may the oxygen supply of the air become exhausted?

What is carbon dioxid? How much fresh air is supposed to be needed by each person in a building? Why does dry air cause a sensation of chilliness? What bad effects follow living in a dry atmosphere? Is there any method of moistening the air used in your school building or in your home? Explain how it works.

Why does one easily become overheated in a moist atmosphere? Describe an experiment that proved the importance of keeping the air in motion. Mention some ways by which air currents may be set up in buildings. In what way have factory owners been repaid for the cost of installing and operating ventilating systems?

What effects have the odors of crowded rooms on certain persons? What may be done to make these odors less noticeable?

Give an account of the open-air school at Oakland, California. For what purpose are open-air schools used in many places? What advancement do the pupils in these schools make in their school work? In outdoor life what point must be kept in mind?

### SUGGESTIONS TO THE TEACHER

Give gymnastic exercises while the schoolroom windows are opened. Insist on the importance of the pupils putting their knowledge of ventilation into practical use in their home life.

Perform for the class experiments with wet- and dry-bulb thermometers (consult Appendix of *Human Physiology*). Bring out that because the skin is kept moist by the perspiration the body is comparable to a wet-bulb thermometer, and that it is the wet-bulb rather than the dry-bulb temperature that is important in regulating the temperature of rooms.

# CHAPTER EIGHT

## ADENOIDS AND COLDS

FIG. 67. Adenoids sap the strength so that any one who is suffering from them has very little chance of being the best athlete in the school; they dull the mind so that the victim of them rarely stands at the head of his class.

AMONG the most common of all the ailments that afflict the inhabitants of the temperate and frigid regions of the earth, are colds and certain other troubles of the nose and throat. These maladies, of course, are not so severe as many other diseases, but certainly they cause more inconvenience than all our other lesser sicknesses combined. It is true also that they often weaken the body and lay the foundations for other serious difficulties. People lack the general understanding of these diseases that they ought to have, and in this chapter we shall therefore make a study of them. In order that we may do so more intelligently, we shall first consider the structure of the nose and throat.

**The chambers of the nose.** The air passes through the nostrils into the *nasal chambers.* These long, narrow passages are about three quarters of an inch wide;

they extend up into the head about as high as the level of the eyes, and they run back and open into the throat behind the mouth. They are separated from each other by a very thin, bony partition. On the outer wall of each chamber are three curved and rolled-up bones that stand out in the pathway of the air (Fig. 68). The whole interior of the nasal chambers is lined by the same skin-like *mucous membrane* that is found in the mouth and throat. This is kept moist by a sticky substance called *mucus*.

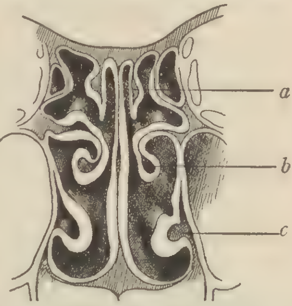


FIG. 68. A cross-section of the nasal chambers, showing the bones (*a*, *b*, and *c*) that stand out in the pathway of the air. The mucous membrane lining the chambers is shown in white.

**The air warmed and cleansed in the nose.** The air in the nose comes in contact with the lining of the chambers, and is drawn in among the bones that stand out in the nasal passages. In this way the air is warmed, and the dust and germs in it are caught on the moist, sticky mucous membrane that lines the cavities and covers the bones. *The function of the nose in respiration is to protect the throat and lungs from cold and from dust and germs.*

**Troubles in the nose.** Sometimes the thin partition between the two sides of the nose becomes bent so that it closes one of the nasal chambers; sometimes the bones in the nose enlarge until they interfere with the breathing and prevent the proper drainage of the nose; and in a considerable number of persons, swollen and overgrown portions of the mucous membrane, called *nasal polyps*, block the air passages. In all such cases, the

obstruction in the nose ought to be removed by a physician who understands how to do the work. If this is not done, the breathing will be interfered with continually, and colds and chronic catarrh are likely to be the result.

**The throat.** The throat is a funnel-shaped cavity which curves backward and downward around the base of the tongue. At its bottom are two openings, one leading to the stomach and one leading to the lungs. In front, a little flap-like structure, the *soft palate*, hangs down from above and partly separates the throat from the mouth. Above and behind the soft palate are two openings which lead into the nose, and high up in the walls on either side of the throat are the mouths of the two *Eustachian tubes*, which are small passageways that lead to the middle ears (Fig. 69). In the walls of the throat are four *tonsils*, which we shall describe in some detail.

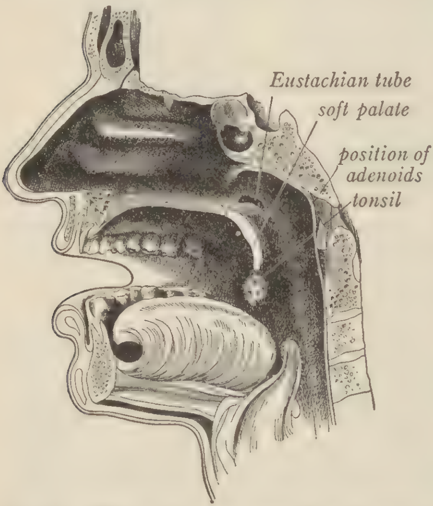



FIG. 69. The nasal passages, mouth, and throat.

**The tonsils.** One small tonsil lies in the back of the tongue; one is high up in the back wall of the throat; and the other two lie in the side walls of the throat.

These structures are composed of loose, spongy tissue, and leading down into them are small openings, or *crypts*, which are formed by folding the mucous membrane down into deep little pockets (Fig. 70). Germs grow in these pockets and cause tonsillitis, — a disease in which the tonsils are swollen and have matter in them like that found in boils. In many persons the tonsils are always infected with germs and become so swollen and enlarged that they block the throat and interfere with the breathing. The tonsil which is most commonly enlarged is the one in the back wall of the throat, and the spongy, swollen, whitish mass of soft tissue into which this tonsil changes is called *adenoids*, or *adenoid growths*. Usually, when adenoids are present, the other tonsils also are enlarged, but this is not always the case.

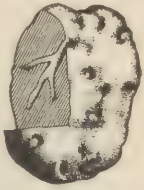


FIG. 70. A tonsil. A part of the tonsil is cut away to show a crypt.

**The symptoms of adenoids.** In moist climates one fourth of all the children may have adenoids. The most easily recognized symptom of them is mouth breathing. If the throat is entirely blocked by them and the tonsils also are enlarged, the mouth will be kept open so wide that any one will notice that the child is a mouth breather. If the throat is only partly filled, the child may keep his mouth open only a little, and the mouth breathing may not be noticed at all, except when the child has a cold or is asleep. After the adenoids

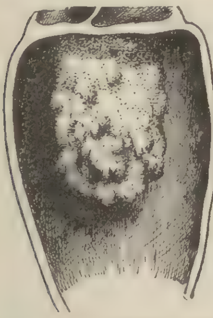


FIG. 71. Adenoids in the throat seen from the front. (*After Wingrave.*)

have been growing for some time, the upper teeth begin to turn forward; the face is puffed out under the eyes; the eyes have a strained look and are drawn down at the inner corners; the lips thicken; the upper lip shortens and is turned out; there is often a white line running down from the corner of the nose marking off the division between the cheek and lip; and the whole face has a dull, stupid look.

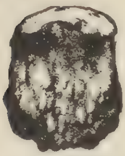


FIG. 72. Adenoid growth that has been removed. One half natural size. (*After Wingrave.*)

In many cases of adenoid growths, the germs work their way up the Eustachian tubes and cause earache, which is an almost certain symptom of them. They also interfere with speech, and any one who "talks through his nose" or has difficulty in pronouncing his words clearly, probably has his nasal passages blocked by them. A child with this trouble usually snores, and in bad cases sometimes gasps and struggles for breath during sleep.

Besides these symptoms of adenoid growths, there are certain other effects that often go with them. Sometimes children who have them are very restless and nervous, and are unable to keep their attention fixed on any one thing. Often they are stupid at their books and fall behind in their school work. Usually the digestion is disordered from swallowing the multitudes of germs that come from the adenoid and tonsils. Often the chest is narrow and the child is undersized, — sometimes two or three years smaller than he should be. Another effect of adenoids, very noticeable in some cases, is a fretful, quarrelsome, and seemingly perverse disposition, — a lack of self-control and a tendency to

fly into a rage at the slightest provocation. This causes the victim to make trouble for his parents, for his teacher, and for all who have anything to do with him.

**The remedy for adenoid growths and infected tonsils.** The only thing to do for adenoids and infected tonsils is to have them out at once. When performed by a skilled

FIG. 73. Typical adenoid faces.

surgeon this operation is not severe, and in thousands of cases it has resulted in an improvement in the condition of the child that is almost miraculous. One sixteen-year-old boy gained fourteen pounds in three weeks after having his adenoids and tonsils removed; and it is a common thing for a child whose adenoid growths have been taken out to make a sudden increase in height and weight and to renew his interest in his school work.

**The evil consequences of waiting to outgrow adenoids.** Usually, but not always, adenoids disappear by the time

a person is grown.[1] It must not be thought, however, that their evil effects disappear with them; for if the nostrils are not used in breathing, the nasal chambers and the upper part of the face do not grow as they should, and the person is left with narrow air passages, protruding upper teeth, a short, thick upper lip, and often with a catarrh and a swollen condition of the nasal mucous membrane that will remain with him for life. Neglected adenoids spoil the beauty of the face for all time, and it is estimated that three fourths of all deafness is due to them. Any one who advises waiting to outgrow adenoids is giving the worst advice possible. They ought to be removed, and this ought to be done before they interfere with the growth of the bones of the nose and face.

**Colds.** Colds are caused by germs that live on the mucous membrane of the nose and throat. They may be divided into two classes, — *epidemic colds* and *chronic colds*. Epidemic colds are caused by germs of a particularly virulent strain that are handed from one person to another until the disease sweeps the community. Most of us must either endure these colds or find a way to escape the germs that cause them — no easy thing to do when people who have colds insist on shaking hands with us and leaving with us a few millions of the germs with which they are so bountifully supplied.

Spraying the nose with something that will kill the germs often helps to check a cold in its early stages.

[1] A case of adenoids has been reported in a child six weeks old and one in a man of seventy years. They are by no means to be thought of as a disease of children only, for many cases are found in persons up to forty years of age.

A hot foot bath cannot kill the germs in the nasal passages, but it helps to draw the blood away from the congested parts and assists in correcting the disturbances of the circulation that accompany a cold. It may also relieve to some extent the headache from which the victim of a violent cold suffers. A hot bath taken before going to bed is even better than a foot bath for drawing the blood away from the congested parts.

In chronic colds, the germs remain with the person all the time, growing only a little when he is in good health and offers a vigorous resistance to them, and springing into greater activity whenever the person gets his feet wet, becomes chilled, loses sleep, or does anything else that weakens his body and lowers its resistance to germs. A person with a cold of this kind is like a country invaded, but not conquered, by an enemy. At one time the inhabitants of the country drive back the foe and give themselves a breathing spell; at another time the advantage is with those who make the attack. The patient's only hope of victory over his germ enemies is to build up his health until his body has sufficient fighting powers to drive them out completely. The following practices have been found important in giving the body strength for this work: —

*Clearing out the nose and throat.* Adenoids, enlarged tonsils, bent and enlarged bones in the nose, and anything else that prevents a free passage of the air through the nose and a free drainage of the mucus from it, turn the nasal chambers into splendid homes for countless germs. The battle against colds is a battle against germs, and we cannot hope to succeed if the enemy is intrenched behind fortifications.

*Getting enough fresh air.* Experience with both consumptives and well persons shows that no one thing is so important as fresh air in giving the body the power to kill germs. Many persons suffer continually from colds because they live and work in buildings where the air is dry and overheated, and any one who wishes to free himself from a chronic cold must include fresh air in his plans.

*Keeping the bowels open.* When refuse matter does not pass promptly through the intestines, it putrefies and produces poisons that break down the health of the whole body (pages 391–392). These poisons destroy the power of the body to resist germs, and they injure the nervous system so that the blood vessels are not properly controlled. The feet of persons who are in this condition are therefore often cold while other parts of the body are congested with blood, and the circulation in general is not regulated as it should be. This disturbance of the circulation is in itself favorable to the growth of germs and makes the cure of a cold difficult. The remedy is to get the digestive system into good working order, and many persons recover from chronic colds when they do this (pages 382–393).

*Taking cold baths.* The practice of taking cold baths helps to give freedom from colds. Probably one way that it does this is by bringing out the white blood corpuscles that kill germs; for it is found that the white corpuscles are more abundant in the blood after a cold bath than before it. Another way that a cold bath helps is by teaching the blood vessels in the skin to open and close promptly. When cold strikes the body, these vessels ought to close and thus keep the

blood in the inner parts where the heat of the body will not be lost. Then, when the cold is removed from the skin, the vessels ought to open and allow the blood to come to the surface of the body. In some persons who are in bad health, the nervous system which governs these vessels does not control them properly, and the vessels in the skin may not close promptly enough to prevent the escape of the heat from the body; or, at the slightest feeling of cold on the skin, the blood vessels may shut up tight and gorge the inner parts of the body with hot blood, while the skin is left cold and shivering.[1] Cold baths help to train the vessels of the skin to open and close properly, and to keep the right amount of heat within the body. In beginning to take baths of this kind, intelligence and care are necessary ; otherwise much harm may be done (page 300).

**Drafts and colds**. People are sometimes advised to pay no attention to drafts and to open the windows, no matter how cold the weather may be, because it is germs and not drafts that cause colds. Yet many persons know from their own experience that sitting in a cold draft does cause them to sneeze, to feel chilly, and often to become actually sick. How can the idea that it is beneficial to the health to sleep where the wind will blow over you, be reconciled with the idea that a draft of cold air is dangerous? If motion in the air is desirable, why not have as much of it as possible?

[1] It should be understood that in chills, such as we have in malaria or at the onset of grip or pneumonia, the difficulty is that the blood has been driven to the inner parts of the body, and the skin, where our sense of feeling is, no longer is warmed by the blood flowing through it. There is no lack of heat in the body, for often a person has several degrees of fever at the same time that he is having a chill.

In the first place, it must be understood that drafts of cold air take the heat out of the skin, and that a person who is exposed to them should have sufficient extra clothing to enable him to keep up his body heat. This keeping up of the body temperature is fundamental in the preservation of the health, for the resistance of the body to germs is weakened at once by the loss of too much heat. Much damage may be done by compelling school children who have been accustomed to hot rooms to sit in their ordinary clothing with the windows wide open on a cold day.

In the second place, it must be recognized that persons who have chronic colds — those who are carrying a host of germs just ready to break through their resistance and put them to bed — are already sick. It must also be recognized that what is safe for a well person or for one accustomed to it, may be neither safe nor wise for a sick person or for one not accustomed to it. When cold air strikes a person who is in a half-sick condition, the vessels in the skin close more than they should. The result is that the blood is driven inward, so that in a few minutes the person can feel the mucous membrane in his nose swelling from the great supply of blood in it. This gorging of the membrane of the nose with blood causes a great quantity of lymph to escape among the cells, and it weakens the resistance of the mucous membrane so that the germs on it multiply more rapidly.

Cold drafts may thus cause a cold in a person who is in ill health by disturbing the circulation and the distribution of the blood; or perhaps it is better to say that cold drafts make a chronic cold worse in this way. It

is not advisable, therefore, for a person who is weak or half-sick to expose himself suddenly to severe conditions.

**Training the body to endure ordinary exposure.** A person who suffers from chronic colds needs to build up the strength of the body gradually; to accustom the vessels of the skin to cold baths gradually so that they will act properly instead of throwing him into a chill when a blast of cold air is felt; to clear the nasal passages and the throat of obstructions; to stop the poisoning of the body by decaying intestinal wastes; and, in general, by degrees to bring the body back to where it will be able to stand ordinary exposure without injury and to kill the germs that are causing the cold. Any one who is always having colds ought, therefore, to begin to build up his health, and if he is wise he will get a good physician to guide him in this task.

**Catarrh and bronchitis.** Catarrh is a chronic cold in the head. Bronchitis is a chronic cold in the bronchial tubes. In both cases the body is kept poisoned by the germs that are growing in it. Recently it has been discovered that in most cases of these diseases, the germs spread from permanent breeding places in the tonsils or the nasal sinuses,[1] and that treatment is useless until the homes of the germs are broken up. There is often no swelling or pain in the infected parts, and many persons who are greatly in need of medical attention go for years without it. Since infections of these kinds are believed to cause many cases of rheumatism, heart and kidney disease, and other serious ailments, they should be given prompt medical care.

[1] The nasal sinuses are cavities in the bones that open off from the chambers of the nose.

## QUESTIONS

Describe the nasal passages. What effect has the mucous membrane upon the air that passes over it? Name three troubles that may occur in the nose, and the remedy for them. Describe the throat. What is the soft palate? What and where are the Eustachian tubes?

How many tonsils are there? Where are they? Of what kind of tissue are the tonsils composed? What is the cause of tonsillitis? What are adenoid growths?

Give five symptoms of adenoids that show in the face. Give other symptoms and effects of adenoids. What is the remedy for adenoids and enlarged tonsils? Mention some bad effects of allowing children to wait to outgrow adenoids.

By what are colds caused? Distinguish between epidemic and chronic colds. Give three ways by which the body resistance to the germs of colds may be raised. How does the practice of taking cold baths protect one from colds? Explain how a cold draft may be injurious. What should a person who has chronic colds do to bring his body back into normal condition?

What is catarrh? What is bronchitis? What bad effects have they upon the body?

## SUGGESTIONS TO THE TEACHER

In every school that is without medical inspection many undiscovered cases of adenoids and enlarged tonsils may be found. It is a simple matter to learn to recognize the symptoms of these troubles, and the teacher can do no greater service than to call the attention of parents to the children who are suffering from them. Among the arguments that may be advanced in asking that the afflicted children be given medical attention are:

The wasting of the school opportunities of the child; the fixing for life of habits of idleness; the danger of injury to the hearing; the permanent catarrhal effects; and the marring of the regularity of the teeth and the beauty and symmetry of the face.

# CHAPTER NINE

## CLOTHING AND THE BODY HEAT


FIGS. 74 and 75. The object of clothing is to keep up the body heat.

A MAN in the cold arctics loses much more heat than does a man in the warm tropics. Yet the temperature of the human body all over the world is the same. A man who is exercising violently produces five or six times as much heat as a resting man produces. Yet the temperature of the human body during exercise and rest is practically the same. Cold-blooded animals become warm or cold according to the temperature of their surroundings, but the warm-blooded animals, including man, keep their heat near a certain point whether the weather is hot or cold. In health the temperature of the human body varies from 98.8 degrees to about one and one half degrees below this point.

**The object of clothing.** We take our clothing so much as a matter of course, that we often forget that the one great purpose in wearing it is to protect us from cold. It is true that it protects the body from wounds also, and we pay great attention to it because of its effect on our appearance; but yet the fact that the inhabitants of the

frigid regions are clad from head to foot in furs, while those who live in the tropics are often very scantily clad, shows that man put on clothing, just as he built houses, to protect himself from the weather. We ought not, therefore, to become so interested in the colors and the appearance of our clothing that we forget the real reason why it is worn.

**The necessity for a regulator of the body heat.** To a certain extent we can regulate the heat of the body by wearing heavy clothes in winter and lighter clothing when the weather is hot. Yet we cannot regulate the loss of heat from the body by clothing alone; for the temperature of the body must be kept constantly at one point, while the thermometer often runs up and down 20 or 30 degrees in a single day. There must, therefore, be some delicate regulator that will govern the loss of heat from the body according to the changes in the temperature of the air. This work is done by the skin.

FIG. 76. A section of the skin.

**The structure of the skin.** The skin is composed of a tough outer layer called the *epidermis*, and of a deeper layer of connective tissue called the *dermis*. The outer

cells of the epidermis are dead and are continually scaling off, but the cells in the lower part multiply and grow to take the places of those that are lost. The dermis contains the nerves of touch and great numbers of small blood vessels. Below the dermis is a layer of loose connective tissue in which a considerable quantity of fat is stored. This layer of fat helps to retain the body heat.

**Hair follicles and sweat glands.** At certain points the epidermis is folded down into deep pockets called *hair follicles*, from the bottom of which the hairs grow. At other points *sweat glands* run down from the outer surface of the epidermis and lie coiled in the dermis. The sweat glands are hollow tubes, the lower ends of which are surrounded by lymph. Water from the lymph soaks through the walls into the tubes and flows out of the mouths of the glands as sweat.

**The body heat regulated by the sweat glands and vessels of the skin.** The temperature of the body is regulated by the sweat glands and the small arteries of the skin. During hot weather and when we do hard work, the sweat glands assist in cooling the body by pouring out sweat on the surface of the skin. The evaporation of the sweat cools the skin, just as alcohol cools it when allowed to evaporate from it. The arteries do their part of this work by controlling the amount of blood that comes into the skin. When the body is exposed to cold, these small arteries contract and keep the blood in the warm inner organs. When the body is heated, they relax and allow the blood to come to the surface, where it will be cooled.

**The danger of chilling the body.** Chilling the body disturbs the circulation by driving the blood from the skin and congesting the inner parts of the body. This makes us especially liable to be attacked by the germs of pneumonia, influenza, and colds, — all of them germs that are often in the air passages waiting for a favorable opportunity to set up their growth. Wet footwear takes the heat out of the feet, thus causing the mucous membrane of the air passages and lungs to be gorged with the blood that ought to be in the lower limbs, and interfering with the germ-killing function of the white corpuscles. The wearing of rubbers when they are needed to keep the feet dry is a most important precaution in guarding against colds.

**Danger of overheating the body.** Working in a hot, moist atmosphere is very exhausting, and it is almost impossible to keep up the health during the summer months unless we can have air currents to blow away the hot air from about the body. Often these can be secured by sleeping and working outdoors, by opening windows, and by the use of ventilators and electric fans. Some persons do not yet realize that from the standpoint of health it is as important to keep cool in summer as to keep warm in winter. Accordingly, they are willing to pay large sums to heat the rooms in which they live and work in winter, but are not willing to spend a small sum for ventilators and electric fans to be used during the heat of the summer. Just as being chilled in winter makes us liable to attacks of influenza and pneumonia, so overheating in summer lowers our resistance to germs and makes us liable to attacks of diarrhea, dysentery, and other summer diseases.

**Suiting the clothing to the weather.** Men who are brought into hospitals suffering with sunstroke are often found to be wearing heavy coats and undershirts, and thick woolen trousers. Little babies in hot summer weather are often covered with "nettle rash" and "heat rash," because they are dressed in such heavy clothing that the skin is kept in an overheated condition. On the other hand, we often see people going without wraps and overcoats when the weather is so cold that the body heat can scarcely be kept up with the heaviest clothing. What we need to remember is that the object of dress is to keep the proper amount of heat in the body. In the spring and fall, especially when the weather is changeable, it is important that the weight of the clothing correspond to the needs of the body.

FIG. 77. A Filipina wearing a costume that is attractive and well suited to a warm climate. The material of which the clothing is made is thin, and the large sleeves and open neck allow the heated air to escape from around the body.

**Bathing.** One object of bathing is to cleanse the body. This we need not discuss. Bathing as it relates to health is mainly a question of the temperature of the water. Cold baths educate the vessels of the skin so that they learn to open and close quickly and thus regulate the body heat properly. The importance of having the blood vessels trained to do this is better appreciated when we remember that animals in the

natural state must adapt themselves only to changes in the weather, while man often passes in a few seconds from an artificially heated building into an outdoor atmosphere that is 30 or 40 degrees colder. When these quick changes from warm to cold air are made, the vessels ought to contract promptly and shut the blood off from the skin before too much heat is lost from the body.

The training of the blood vessels through cold baths is of course mainly a work of training the nervous system which controls the vessels, and if a person is weak and out of condition, a cold bath may have about the same effect on his nervous system that a long race would have on the muscles of a person not accustomed to taking exercise. In beginning to take cold baths, therefore, we must use care. They ought to be begun with water that is only cool, the bath should be short, and after the bath the skin should be rubbed briskly with a rough towel. Colder water may be used as the skin becomes accustomed to it, but in no case should the water be so cold or the bath so prolonged that the reaction fails to come promptly; for when this is the case, the blood congests the inner organs and a headache is the usual result.

It is the opinion of some physicians that certain delicate persons are never able to take cold baths without injury; that baths of this kind are injurious to any one who is in poor health or in a nervous condition, and that only those who are strong and in robust health can bear the shock of such a bath without injury. Others think that any one can train himself to take them with safety. This question we must leave to the physicians to decide.

**Alcohol and the body heat.** In cold weather, taking alcohol causes a feeling of warmth, and men often take a drink to enable them better to endure cold. The feeling of warmth that is given by alcohol is deceptive. We feel cold when the blood has been shut off from the skin and warm when the hot blood from the inner parts

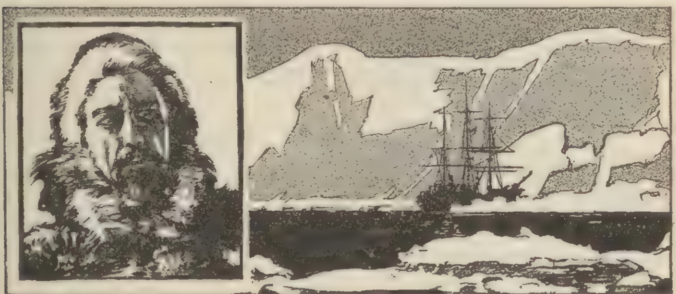


FIG. 78. Captain Roald Amundsen, who discovered the South Pole. Because alcohol lessens both the endurance of the muscles and the power of the body to resist cold, none of it was used on the Amundsen expedition.

of the body is flowing through the skin. Alcohol temporarily paralyzes the arteries of the skin and leaves them expanded. This allows the skin to become flushed with blood, and causes a sensation of warmth, but at the same time it allows the blood to be cooled and the body heat to be lost. When we are exposed to cold, the vessels ought to be contracted and we ought to feel cold. Hence to bring the blood into the skin so that the body heat will be lost is an unnatural and unsafe thing to do. Persons who use alcohol cannot endure cold so well as persons who do not use it, as the experience of polar explorers proves.

## QUESTIONS

What is the temperature of the body? What is the purpose of clothing? Why must the body have some means of regulating its heat?

Name the two layers of the skin. Describe each. Describe a hair follicle. Describe a sweat gland. What is the source of the sweat?

Explain how the heat of the body is regulated. In what two ways does chilling the body injure it? How may wet feet injure the health?

What is the effect upon the health of overheating the body? Why are air currents especially important in summer? How may they be secured? Discuss the subject of suiting the clothing to the weather. At what seasons of the year should we be especially careful to change clothing according to the weather?

What do cold baths do for the vessels of the skin? How should one unaccustomed to cold baths begin to take them?

Why does taking alcohol give a sensation of warmth? What has been the experience of polar explorers in regard to the power of drinkers and of abstainers to withstand cold?

## SUGGESTIONS TO THE TEACHER

Have the pupils explain why an athlete throws a sweater over his shoulders when the game stops for a few minutes. Insist that clothing should be adapted to the weather and not to the season.

Bring out the difference between cold-blooded and warm-blooded animals and point out that practically all warm-blooded animals are protected by feathers or by hair.

# CHAPTER TEN

## THE NERVOUS SYSTEM

THE work of the nervous system has always been a mystery to mankind. The ancient Greeks thought that the brain distilled some kind of vital spirit, or essence, which flowed out through the body in the form of a gas. If the brain were injured so that the supply of this spirit was cut off, or if the body were deeply wounded so that the vital spirit escaped, life came to an end.

FIG. 79. The nervous system.

Today we know a great deal more than the Greeks knew about the nervous system, but our knowledge of it is yet far from complete. We know enough, however, to help us greatly in the care of the body, and in this chapter we shall take up some of the facts concerning the nervous system that it is most important for us to understand.

**The parts of the nervous system.** The nervous system is composed mainly of the *brain*, the *spinal cord*, and *forty-three pairs of nerves* that run out from the brain and the spinal cord to all parts of the body. It includes also many little masses of gray tissue, called *ganglia* (singular, *ganglion*), that are found among the inner organs of the body, and a great network of nerve fibers that run among these organs.

**The function of the nervous system.** *The first function of the nervous system is to control all the organs and parts of the body.* If the heart should beat fast when we lie down to rest and slow when we run; if the sweat glands should pour out water on the skin when we are already freezing and stop work on the hot days of summer; if the muscles moved how and when they pleased, so that they jerked the body aimlessly about; if all the organs worked without system or plan, so that each part of the body carried on its activities without regard to the rest of the body, we should not have a working machine at all, but only a collection of organs and parts. A ruler must, therefore, be set over the whole body to keep all the parts working together properly. This ruler is the nervous system.

*The second function of the nervous system is to act as the organ of the mind.* This function we shall discuss when we take up the study of the brain.

**The nervous system composed of cells and fibers.** The nervous system is made up of *nerve cells* and of *nerve fibers*. The nerve cells are larger than most of the body cells, and have a gray color. Most of the nerve cells are found in the brain and spinal cord, but a few of them are found in the ganglia, which are little balls of nerve cells.

The nerve fibers connect the nerve cells with the other parts of the body. They have a glistening white color, but each fiber has a gray central part which carries messages to and from the spinal cord and brain. This gray core of the fiber is a branch of a nerve cell, and we may think of the nerve fibers as long branches of the cells which run out to all parts of the body. The white nerves that we see in the body of an animal are bundles of nerve fibers. The finest nerves contain but a few fibers, and can be seen only with a microscope. The *sciatic nerve*, which runs to the leg, is the largest nerve in the human body. This is a flattened cord three fourths of an inch across.

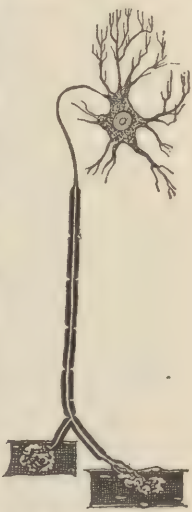


FIG. 80. A nerve cell and nerve fiber. At the lower end the attachment of the fiber to the muscle cells is shown.

**Motor and sensory nerve fibers.** Some of the nerve fibers carry messages from the brain and spinal cord that cause our muscles to move. These are called *motor* fibers. Other fibers carry messages from the skin, the eye, the ear, and other parts of the body to the brain. These messages cause us to feel, to see, to hear, and to understand the condition of all the parts of the body. They cause sensations in the brain, and the fibers over which they pass to reach the brain are called *sensory* fibers.

**The brain.** The brain is a mass of very soft tissue weighing about fifty ounces and filling the cavity of the cranium (Fig. 21). It has three principal divisions, the

*cerebrum*, the *cerebellum*, and the *medulla oblongata.* A general idea of the appearance of the different parts of the brain may be gained from Figure 81.

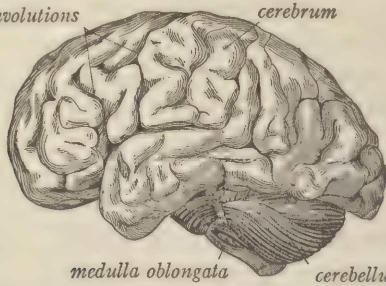



FIG. 81. The brain seen from the side, showing the three principal divisions.

**The cerebrum**. The cerebrum makes up more than three fourths of the entire brain. It is divided by a deep groove into right and left *hemispheres*. The outside layer of the cerebrum is composed of nerve cells, and therefore has a gray color. To make more room for these cells the whole surface of the cerebrum is thrown into folds, or wrinkles, that are called *convolutions*.

From the cells of the cerebrum a great network of fibers runs in all directions through the brain, and connects all its different parts with each other. Other fibers run down through the medulla into the spinal cord and connect the cerebrum with all parts of the body. Most of the motor fibers from the cerebrum are crossed in the medulla, so that the right side of the cerebrum is connected with the muscles of the left side of the body, and the left side of the cerebrum is connected with the muscles of the right side of the body.

**The function of the cerebrum.** *The gray outer layer of the cerebrum is the seat of all intelligence.* Without

it all sensations of light, sound, taste, smell, touch, heat, and hunger are lost. When it is removed, all power of moving the voluntary muscles is gone. The cerebrum, therefore, is the part of the brain that thinks and feels. It is the part that causes us to remember and to know, to love and to hate, to be glad and to be sad. The cerebrum decides what we shall do; it sends out the messages to the muscles when we wish to move; and it governs the whole body. Without its cerebrum an animal can live, but all its intelligence is gone. It still breathes and its heart continues to beat, but it is only a machine, knowing nothing of its own needs and of the world about it.

FIG. 82. The cerebrum seen from above, showing the hemispheres.

**The cerebellum.** The cerebellum lies under the back lobes of the cerebrum. *Its function is to cause all the muscles to keep the proper tension, and to assist in governing the muscles of locomotion.* In walking, more than two hundred muscles are used in holding the body upright and in moving the different parts that are brought into action. Each of these muscles must contract with exactly the right force and at exactly the right time, or they will work against each other and the right movements will not be made. When the cerebellum is injured, all the muscles are weakened and relaxed, and the person loses control of the muscles that support the body and move the legs. This causes him to stagger and reel like a drunken man.

**The medulla and the spinal cord.** The spinal cord is about half an inch in diameter and eighteen inches long. Without the roots of the nerves that rise from it, it weighs about an ounce. It lies in the canal in the center of the spinal column and is securely protected by the bones about it. The enlarged upper end of the cord is the medulla.

Both the spinal cord and the medulla are composed in large part of fibers that connect the brain with the different body parts. Some of these are sensory fibers, through which messages from the body are passed up to the brain. Others are motor fibers, over which commands from the brain pass down on their way to the different parts of the body. In addition, *the medulla contains the centers which govern the heart and lungs.* When the cerebrum of an animal is removed, the intelligence is lost; when the cerebellum is injured, control of the muscles is lost; but when the medulla is injured, life at once ceases, because the beating of the heart and the breathing stop.

**Reflex action.** Much of the governing of the body by the nervous system is done without thought. The messages, or nerve impulses, pass through the sensory nerve fibers into the nerve cells, pass on through the branches of these cells into other cells that are touching them, and come out again by way of a motor nerve. An action that is caused in this way is called a *reflex action*, and it can best be explained by an example.

Cross your legs, and strike yourself just below the kneecap with the edge of your hand. If you strike the right place, you will start messages to the spinal cord. These, without any thought whatsoever on your part, will

pass into the motor nerves and down into the muscles of the leg. The muscles of the leg will then contract and cause the foot to jerk. *A reflex action is an involuntary action caused by an impulse that starts in a sensory nerve.* It is very different from the voluntary actions that are caused by impulses which start in the cerebrum and pass out to the muscles when we wish to move some part of the body. Practically all the governing of the internal organs of the body is carried on by reflexes.

FIG. 83. The ball starts from the hand and comes back to it again. The impulse that causes a reflex action starts from the *outer end* of a sensory nerve and comes back to the muscle or gland that is thrown into action. *It does not start from the brain.*

**Reflexes acquired through practice.** The reflexes that we have been discussing are natural reflexes; we are born with them. There is another set of reflexes that comes to us through practice. The skilled swimmer does not think how he shall move his arms and legs; in boxing, the hands move without thought and almost faster than the eye can follow; the telegrapher does not think about the combination of dots and dashes that spell out a word, but reads the message he is sending, and his hand does the rest. In the same way, all of us every day do a great part of our work without thought. We walk without giving attention to the muscles and parts which we must move; we open our mouths to take in food without thinking; we chew our food without noticing that we

are chewing; we write without conscious thought as to the shape of the letters. All these things we have repeated so often that we have learned to do them without thought.

**Acquired reflexes and education.** A very important part of education consists in establishing the right reflexes, so that without thought we shall do the more common things of life properly. A young person who is learning to write ought to learn to hold his pen in the right way and to shape the letters correctly, so that the right reflexes will be formed and the writing question settled for life. He ought to learn to group his words properly and to give the right inflection in reading, so that these matters will attend to themselves thereafter. He ought to take great care to say "please" and "thank you"; to modulate his voice so that it will not become loud and strident when he is talking eagerly; to take off his hat and to rise to his feet when he should do so; and to do all the other things that go to make up pleasant manners; for no one will ever have good manners who has not established reflexes that will make him able to do what he ought to do naturally and without thought of his actions.

When you are learning to do anything, the great thing is to do it right, so that you will form a reflex action of the right kind. Then as long as you live the part of your conduct and work that depends on this reflex will take care of itself and you will be free to expend your energy on the new problems that arise day by day. The object of the training that you are receiving at home and in school is to make for you a set of tools with which to carry on the work

of your life. If you wish to be a good workman, you must, first of all, manufacture for yourself a good set of tools.

**Habits.** Habits are really reflexes that we form by repeating acts, and just as physical habits can be formed, so can moral habits, and habits of the mind, be formed. All kinds of habits are formed most readily in youth, and it is seldom that long-established habits are broken after the age of twenty-five or thirty. Indeed, it is difficult at any time of life to break a habit that has once been thoroughly established. It is because this is true that young people are so constantly urged to form habits of honesty, neatness, accuracy, and cleanliness. An investigation at Harvard University has shown that the students who do high-grade work in the schools of law, medicine, and engineering are students who did their work well before entering these schools; that it makes little difference what subjects they have studied previously, but that it makes a great deal of difference whether they have formed the habit of learning their lessons regularly and thoroughly, or of going through them in a lazy and careless way. The trifler in the lower grades of school is usually a trifler still in the high school, and very few high-school drones ever become capable and industrious college students.

Just what it is that makes the nervous system want to keep on doing things in the same way, we shall not attempt to explain, but it is a well-known fact that what a man does in youth determines very largely what kind of person he will be in later life. If in youth he forms habits of dishonesty and laziness, he is almost certain to develop into an unreliable and unsuccessful man.

If in youth he forms habits of honesty, industry, and promptness, he will probably become a trusted and a successful man. Rip Van Winkle was always intending to stop drinking, but when a glass was offered him, he would say: "We won't count this time"; so the time to begin his new life never came. There are many persons who have good intentions and are meaning to get down to work in the future, but their habits keep them loitering on in the same old ways. The importance, therefore, of forming correct habits in youth can hardly be overestimated.

#### QUESTIONS

Name the principal parts of the nervous system. Give two functions of the nervous system. Of what is the nervous system composed? Describe a nerve fiber. What are ganglia? What are motor nerve fibers? sensory nerve fibers?

Describe the brain. Describe the cerebrum. How is the cerebrum connected with the other parts of the brain? with all the parts of the body? What is the function of the cerebrum? What part of the cerebrum is the seat of intelligence? Can an animal live if its cerebrum is removed?

Where is the cerebellum? What is its function? What effect upon a person has an injury to the cerebellum?

Describe the spinal cord and the medulla. Why does injury to the medulla cause death?

What is a reflex action? Give an example. Describe the course of the impulse in a reflex action. Describe the course of the impulse in a voluntary action. What is an acquired reflex? How may right reflexes be established? Why is it important to establish this kind of reflexes?

What is a habit? Why is it so important to establish right habits in youth? What did the investigation at Harvard University show in regard to the foundation of good scholarship?

## SUGGESTIONS TO THE TEACHER

Secure if possible prepared microscopic mounts that will show nerve cells, nerve fibers, and the cross-section of a nerve, and have the pupils examine them. For demonstrating the gross structure of the brain, the brain of a sheep is very commonly used. If a sheep's head is not easily available, the head of a cat, rabbit, or fowl may be used. A pair of bone forceps will be needed for breaking away the skull, and after removal the brain should be hardened in alcohol or five per cent solution of formalin.

Make clear that a reflex action is always *involuntary*, but may or may not be *unconscious*. A good example of an unconscious reflex is the expansion and contraction of the pupil that follows shading the eye and then exposing it to the light. With the aid of a mirror the pupil can observe this in his own eye by facing the light, covering his eye with his hand, and then removing the hand. If no mirror is at hand, the experiment may easily be performed on another person. To a great extent the internal organs are governed by reflexes of this class. The winking or dodging reflex may be used to illustrate conscious reflexes.

Emphasize the physical aspects of habit. Bring out the fact that in the doing of our daily work and the living of our daily lives it is inevitable that we shall form either correct habits or wrong habits. The late Professor James' discussion of habit, which may be found in either his *Talks to Teachers* or his *Textbook of Psychology* (published by Henry Holt and Co., New York), is a masterly and inspiring piece of writing. Every teacher may with profit read it himself, and selections from it may be read to the class.

In teaching this and the following chapter, the teacher should bear in mind the importance of fixing quiet, orderly habits of mental work in order that there may be no waste of nervous energy through excitement and overeagerness. Some teachers who are very successful in imparting information fatigue their pupils unduly through the tense, nervous atmosphere of the school. This is coming to be recognized as an important point in school hygiene.

# CHAPTER ELEVEN

## THE CARE OF THE NERVOUS SYSTEM

FIG. 84. There is no truth in the idea that a person can have too much natural sleep.

SUPPOSE that you decide to raise your hand. The hand comes up. Can you explain exactly what made it rise? It is in reality a very complicated action, and to make sure that you understand it we will go through the different steps in it with you.

First of all, you decided to raise your hand. This was an act of the mind. Then nerve impulses, whatever they may be, were started out from the brain. These impulses traveled down through the medulla and spinal cord, passed out into the nerves of the arm, and finally entered the muscle cells. This caused the muscle cells to contract and lift the arm. The muscle did the work, but the nervous system decided what was to be done and caused the muscle to do it.

In all our other activities we find that the nervous system plays a guiding and controlling part. The regulation of the body heat, the secretion of the digestive

juices; the excretion of the wastes; all these processes, as well as every movement that we make, are under the control of the nervous system. We must, therefore, keep the nervous system in health; for when it goes wrong in its work, the whole body suffers. Fortunately for us, our nervous systems are splendidly built, and on the whole they do their work faithfully and well. There are, however, certain points in the care of them in which many persons fail, and we ought to have an understanding of these points.

**Sleep necessary for the nervous system.** The cells of the nervous system must have sleep to build themselves up for further work, and so far as we know they are the only part of the body that needs sleep. The amount of sleep needed varies greatly in different persons and in persons of different ages. A little baby may sleep as much as twenty-two out of the twenty-four hours. At six months of age he sleeps about sixteen hours. At seven years of age a child should sleep eleven or twelve hours; at ten or twelve years of age, at least ten hours. Older persons should take the amount of sleep that they find best for them. Occasionally a person is found who keeps in good health on four, five, or six hours of sleep. Other persons must have eleven or twelve hours. Each one should go to bed early enough not to feel sleepy when getting-up time comes; for there is no truth in the idea that one can have too much healthy sleep.[1]

Are you still tired and sleepy when you waken in

[1] Illness and poisons absorbed from the intestines cause drowsiness. When a person is sleepy from one of these causes, the condition is, of course, an unnatural one.

the morning? Are you pale and languid and do you drag yourself through your work? If you are, it may be because you are cutting your sleep short; for there are thousands of people who are starving for sleep as truly as other people are starving for food and fresh air. If you have fallen into a habit of staying up late in the

FIGS. 85 and 86. A change for a time to a different kind of occupation is restful to the nervous system.

evenings, break this habit and go to bed early. A runner or a baseball team that has been losing sleep has not the slightest chance of winning from others of equal ability who have had a sufficient amount of it. This is because the nervous system, when it lacks sleep, is out of condition and cannot control the muscles as it should.

**Rest necessary to the health of the nervous system.** A great amount of nervous energy is required to drive the more than five hundred muscles of the body, and when we study or do other brain work, it is the nervous system that is called into action. In either physical or

mental work, therefore, we tire the nervous system, and we ought not to continue either until our cells are poisoned with the "fatigue toxins" that appear in the body in cases of exhaustion.

Factory workers who are forced to speed themselves up to machines, and little children in schools where the recitation periods and the school days are too long, suffer from fatigue and cannot do their best work. Many earnest, ambitious individuals who are trying to do the very best work of which they are capable, injure themselves and lower their working power by keeping their nervous systems exhausted.[1] In general, it has been found best to work hard during regular working hours, and then to have rest periods when something entirely different is done. In schools there should, therefore, be rest and play periods for young children, and older persons ought to work certain hours every day and then for a time have a different kind of occupation.

**Fresh air helpful in resting the nervous system.** A nerve fiber from a frog will carry impulses all day without fatigue if it is exposed to the air so that it can take in the oxygen that it needs. If the supply of oxygen be cut off from it, however, it soon becomes exhausted. Undoubtedly children in open-air schools can do more work without becoming tired than can children in indoor schools, and it is the belief of those who sleep

[1] In some factories it has been found that the workmen can accomplish more when they work eight hours than when they work ten hours, because when they work the longer hours they are always tired and never in good condition. The number of hours that is best for a working day must, of course, vary with the kind of work and with the kind of people who are doing the work.

in the open air that they need about an hour's less sleep than they require if they sleep indoors. These facts indicate that fresh air is an aid in preventing exhaustion, and that tired nerve cells are more quickly rested and built up when the body is given plenty of outdoor air.

**A peaceful mind necessary for health.** In our study of the nervous system we must always keep in mind

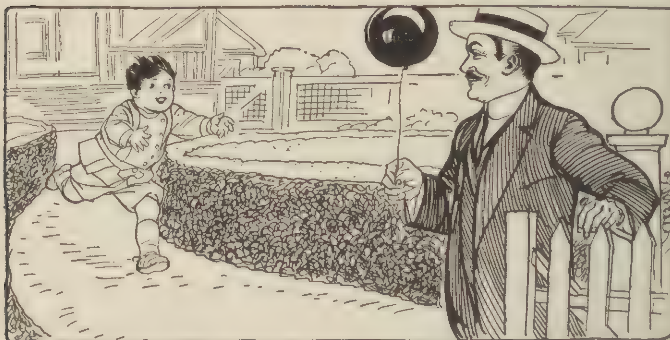


FIG. 87. Both the child's pleasure at seeing the toy and the man's pleasure at seeing the child's happiness affect the mind, and through the mind affect the body.

that it has the double function of governing the body and of acting as the organ of the mind. It is perhaps economical to have these two different kinds of work done by the same system, but this plan has its drawbacks as well as its advantages; for the condition of the mind greatly affects and sometimes interferes with the proper regulation of the body.

Good news or bad news may greatly change the beating of the heart. A toy that pleases a child will cause his whole body to tingle with pleasure, and will cause impulses to pass out to his muscles that will make him

laugh and clap his hands. Food that is pleasing to the taste, or even the sight or smell of food, will cause the "mouth to water," which is another way of saying that it causes the digestive juice to flow from the salivary glands. Experiments on a dog have shown that the sight and smell of food, even though the food does not reach the stomach at all, causes an abundant flow of the digestive juices in the stomach; while in a dog that was made angry by having a cat placed near it when it was eating, the flow of the juice in the stomach was interfered with for two whole days. All these facts show that anger, sorrow, and worry interfere with the proper action of the body; that the mind greatly affects the body; and that a cheerful, quiet, hopeful mind is necessary for health.

At the same time, we must realize that sickness is a real thing, and that when it comes upon us we cannot depend upon the mind alone to restore us to health. When a child has diphtheria, only antitoxin will save its heart from being poisoned, and when tuberculosis attacks the lungs, good food, fresh air, and rest, as well as cheerfulness and hope, are needed if the body is to make a winning fight against the germs. When the kidneys have been poisoned by scarlet fever or by the use of alcoholic drinks, nothing that we can think about them will make them able to throw the wastes out of the body as a pair of sound kidneys are able to do. The mind cannot take poisons out of the body; it cannot kill germs that get into the body. These things the body must do for itself, and all that the mind and the nervous system can do is to help to keep each organ of the body at work at its particular task.

Nevertheless, it is true that the nervous system rules the whole body; that when the nervous system goes wrong, the whole body goes wrong; and that just as food, fresh air, exercise, and rest are necessary to the health of the body, so a peaceful, hopeful mind is necessary in order that the nervous system may remain in health and regulate all the body parts properly.

### QUESTIONS

What part of the body needs sleep? How much sleep should a baby have? a child seven years old? a child twelve years old? an adult?

Why is rest necessary for the nervous system? Under what conditions of work and rest can a person do the best and most work? Give three facts indicating that open-air life prevents exhaustion of the nerve cells.

What is the effect of joy, hope, and other pleasant emotions on the nervous system? What is the effect of anger, sorrow, or worry? What mental state is necessary to the health of the body? Mention some experiments with animals that prove this. Can the mind take poison out of the body? Can it kill germs? How can the mind help the body to do these things?

### SUGGESTIONS TO THE TEACHER

Emphasize the fact that nerve cells have the same needs as the other cells and that any trouble in other parts of the body is bound to damage the nervous system. Dr. Thomas D. Wood of Columbia University estimates that "15,000,000 out of the 20,000,000 children in the schools of the United States need attention for physical defects which are partially or completely remediable." Insist on the evil effects of pain and ill-health on the nervous system, and use this as an argument for avoiding infections and for giving attention to adenoids, decayed teeth, painful feet, defective eyes, and other physical defects.

# CHAPTER TWELVE

## THE EYE

MANY of the messages which travel up the nerves to the brain are started within the body itself, and cause sensations that tell us about the condition of the body. Examples of sensations of this kind are sleepiness, fatigue, weakness, faintness, hunger, thirst, and nausea.

Others of the messages that come to the brain are started in the nerves by things that are outside the body, and these messages bring us information about the outside world. The nerves that carry these messages are the nerves of *sight*, *hearing*, *touch*, *taste*, and *smell*. Seeing, hearing, touching, tasting, and smelling are the five special senses, and the eye, the ear, the nose, the mucous membrane of the mouth, and the skin are the special sense organs.

**The brain dependent on the sense organs for information**. Through the special sense organs we learn all that we know of the world about us, and when anything interferes with the proper working of these organs, much information that ought to come to the brain fails to reach it. Many children who are thought to be stupid are dull, not because they have slow brains, but because their eyes and their ears are not quick in gathering the information that is necessary to make them intelligent. We must learn to care for our sense organs, especially for our eyes and ears, for without them the brain sits in idleness, and is no more certain of what is the right thing to be done than is the commander of an army whose scouts bring him no news of the enemy's movements.

**The nerves in the eye stimulated by light**. Light is waves in the ether which fills all space, and the eye

is an instrument so constructed that when light enters it the nerves of sight are stimulated and messages are started to the brain. These messages give us a series of pictures of the world about us, from which we learn about the color and the form of objects, about their movements and their nearness to us. From these pictures much of our knowledge comes. Much of the pleasure also that we have in the world comes from them; for just as music starts messages from the ear that give pleasure to the mind, so beautiful objects start messages from the eye that are pleasing to us. Years ago, a great man of science suggested that we should have concerts of beautiful colors for the eyes as well as concerts of music for the ears. Such concerts have already been attempted.

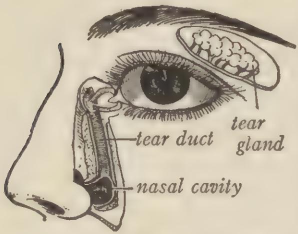


FIG. 88. The tear gland and the duct that carries the tears to the nose.

**The protection of the eyes**. The eyes are protected from blows by the deep sockets in which they lie, and by cushions of fat on which they rest and turn. They are protected from dust and sweat, and screened from light, by the eyelids, the eyelashes, and the eyebrows. In the outer corner of each of the upper eyelids is a small gland which secretes the tears. These flow across the eyes to the inner corners, and run down a little duct into the nose. In their passage across the eye, the tears wash away dust and germs. In the eyelids are glands, very similar to the glands that oil the hair, which pour out oil along the edges of the eyelids. Sometimes these glands become diseased, and the secretion from them

dries and forms scales around the roots of the eyelashes. The trouble in cases of this kind is that germs are growing in the gland. Dropping a solution of boracic acid (as much as will dissolve in water) into the eyes will help to kill the germs.

**The muscles of the eye.** The eye is moved about by six muscles. The back ends of these muscles are attached to the eye sockets. The front ends are attached to the ball of the eye. These muscles can turn the eye in, out, up, or down. It is not necessary always to turn the head toward an object which we wish to see; for the eye muscles can turn the eye toward it while the head is at rest.

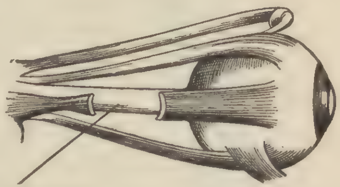


FIG. 89. The muscles that move the eye.

In some persons from birth the sight of one eye is better than that of the other eye. Such a person may fall into the habit of using only his good eye, and the muscles of the weak eye will not turn it toward the objects he looks at. A person whose eyes behave in this way is said to squint, or to be cross-eyed. Usually the trouble can be remedied if it is taken in time, but if it is not attended to in very early life the sight of the defective eye will be lost. A little child with this trouble should, therefore, have proper treatment at the earliest possible date.

**The structure of the eye.** The eye has a tough, white outer coat called the *sclerotic* coat; a dark middle coat called the *choroid* coat; and lining the back two thirds of the eye, a delicate inner coat called the *retina*. The

front part of the sclerotic coat, which is called the *cornea*, is transparent like glass, and we look out, or rather the light comes in, through a little window that is like a small round watch crystal on the front of the eye.

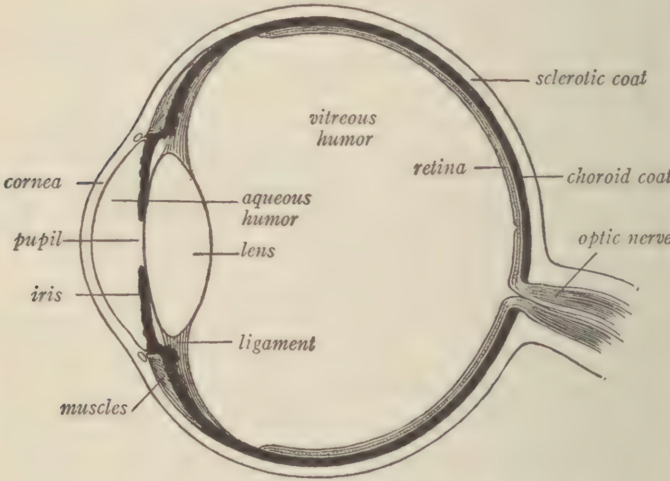



FIG. 90. A diagram showing the structure of the eye.

Inside the eye is found a circular, clear structure called the *lens*, which is fastened by ligaments to the choroid coat. The lens and the ligaments that support it divide the eye into a small front chamber and a large back chamber. The front chamber is filled with a watery liquid, called the *aqueous humor*. The back chamber contains a clear jelly-like substance called the *vitreous humor*. The nerves of sight enter at the back of the eye and spread out in the retina. The light reaches these nerves and starts messages in them by passing in through the cornea, the aqueous humor, the

lens, and the vitreous humor, and striking against the retina.

**The iris and the pupil.** The front part of the choroid coat is called the *iris*. This shows through the clear cornea, and the person is black-eyed, brown-eyed, or blue-eyed according to the color of his iris. In the center of the iris is a circular opening called the *pupil*. Through this the light passes into the eye. Muscles in the iris regulate the size of the pupil according to the brightness of the light, Examine your own eyes after being in a bright light and again after being in a weak light, and you will have no trouble in seeing the difference in the size of the pupils.

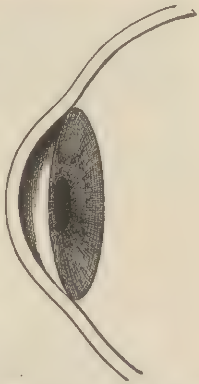


FIG. 91. The iris and the pupil.

**The image formed by the lens on the retina.** If you were to focus a camera on a group of objects, as for example a house with trees surrounding it, and then look at the ground glass in the back of the camera, you would see an image of the scene that lies before the camera. The image would be upside down, and the right and left sides would be reversed, but the house and the trees would be there, each with its own colors, and each in the right position in the group. The lens in the front of the camera forms this image by gathering up all the light that comes into the camera from each of the objects, and bringing the rays together so as to form a picture of all the objects.

In the same way, the lens of the eye forms on the

retina images of the objects that we see. In the eye, as in the camera, the images are upside down, but they are there in their proper colors, and the different objects have the right sizes and the right positions in regard to each other. This picture of whatever we are looking at starts impulses in the nerves of sight to the brain, and when these messages are received by the brain, we form judgments about the size, color, and form of the objects, and say that we see the objects. By means of the images in the eyes we can judge also of the distances of objects from us, of their movements, and of their smoothness or roughness.

FIG. 92. The lens in the camera forms inverted images on the ground glass in the back of the camera.

**The shape of the lens changed in looking at far and near objects.** In looking at a near object the lens of the eye must be rounded up, and in looking at a far object it must be flattened. This rounding and flattening of the lens is done by little muscles in the eye which loosen and tighten the ligament that supports the lens. If you should fill a small sack with water and then pull on the ends of the sack, you would flatten it; and if you should then stop pulling on the ends of the sack, the sack would of itself round

up. So in the eye, when the ligament is loosened, the lens becomes rounder. This change in the shape of the lens is called the *accommodation* of the eye, because by it the eye is accommodated to the nearness or farness of the object.

**Near-sightedness, far-sightedness, and astigmatism.** In a camera, if you move the lens too far forward or backward, the image becomes blurred. So in the eye the image will not be clear and the vision will not be distinct, unless the lens is the right distance from the retina.

The eyes of some persons are too long from front to back. In such eyes the lens is too far from the retina and the image is indistinct. These persons see near objects better than far objects, and they are therefore said to be near-sighted. Any one who bends over his book in reading, or who holds his book less than twelve inches from his eyes, is near-sighted.

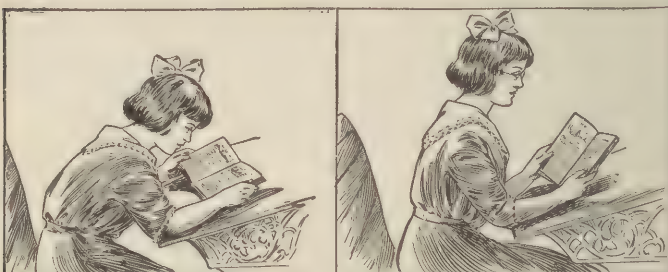
The far-sighted eye, on the other hand, is too short from front to back, and the lens is too close to the retina.[1] Persons with eyes of this kind see distant objects best, and they are said, therefore, to be far-sighted.

In other eyes, the curvature of the cornea is not the same in all its parts; that is, some parts of it are flatter than other parts. Rays of light that pass through this uneven cornea cannot all be brought to a focus at one point, and a clear image is impossible in such an eye. This trouble is called *astigmatism.* It is a very common defect in the eye and may be found alone, or along with either near-sightedness or far-sightedness.

**Necessity for a clear image in the eye.** If a sharp,

[1] In some cases of near-sightedness and far-sightedness the trouble may be in the shape or the refracting power of the lens.

clear image is not formed on the retina of the eye, serious troubles follow. The muscles in the eye keep pulling and working to try to change the shape of the lens so that the vision will be clear; in reading it is a strain on the attention to tell what letters are in the words, and, in general, it makes all work that requires close attention more difficult. This overworks and deranges the nervous system, and soon the health of the whole



FIGS. 93 and 94. There are 5,000,000 school children in the United States who need glasses.

body is injured. Two of the most common symptoms of eyestrain are headache and trouble with the digestion, often accompanied by dizziness and vomiting.

**The importance of spectacles.** It is often said that the great amount of close work that people now do injures their eyes, and it is insisted that the eyes of school children in particular are damaged by the work that they are required to do. There is doubtless some truth in this statement, but it is also true that many eyes are naturally defective. Examination of the eyes of the Indians who come direct from the plains to Hampton Normal School, in Virginia, shows that 34.6 per cent

of them are in need of glasses to improve their vision or to relieve eyestrain.

It is estimated that there are 5,000,000 school children in the United States who have defective eyes. Nothing can be done for these eyes except to put glasses before

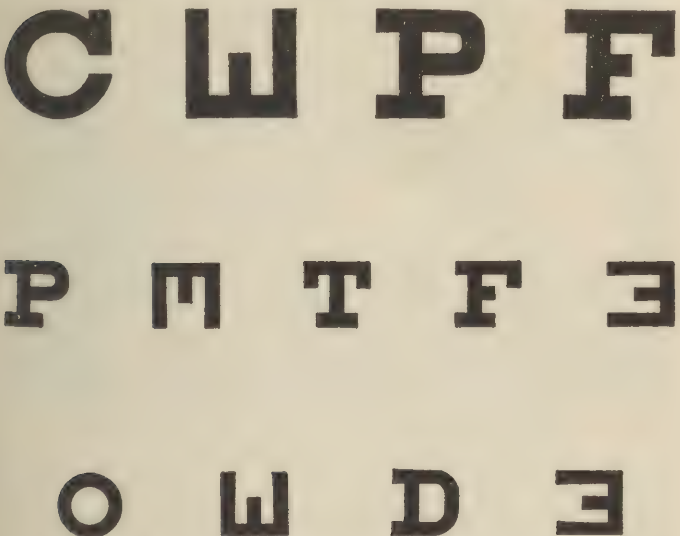


FIG. 95. You should be able to read the upper line at a distance of 30 feet, and the two lower lines at a distance of 20 feet.

them that will cause clear images to fall upon the retinas. We shall not attempt to explain the kinds of glasses that are used to correct the different kinds of eye trouble, but it is an easy matter for a good oculist to select the kind of lens that each eye needs. Test your vision with the letters given on this page, and if you have reason to believe that you need glasses, try to get them; for if glasses are put on in time, many cases

of astigmatism and near-sightedness will be outgrown, while if these troubles are neglected, the shape of the eye may be so spoiled that the person will be compelled to wear glasses all his life.

**The eyes injured by disease germs.** In measles, scarlet fever, and smallpox, the germs grow in the eyes. During the progress of these diseases the eyes should be rested and shielded from a bright light, and when the eyes have been severely attacked, they should not be used until recovery is complete. "Pink eye" is a highly infectious disease that often leaves the eyes red and inflamed for life. It is spread by germs that are passed from one person to another, and a child with "pink eye" ought not to be in school. *Trachoma*, or "granulated lids," is another germ disease of the eyes that is greatly to be feared. It is infectious, and it is unsafe to be around a person who is suffering from it. Do not wash your eyes in a public wash basin; do not touch a public towel; do not touch your eyes with dirty hands; and do not touch the hands, the pencil, or the books of any one who has sore eyes.

**Importance of a good light while working.** To read or to work by a dim light is very injurious to the eyes. Too bright a light also is injurious, especially if one faces it, and a flickering light of any kind is bad. In writing one ought to sit so that the light comes over the left shoulder; for then the shadow of the hand will not interfere with the work. Facing a window in the daytime, or a lamp at night, is hard on the eyes. Reading on into the twilight is a great strain on the eyesight, and one ought not to seat himself carelessly too far from the light when doing close work at night.

One difficulty when the light is too dim is that the work is kept so close to the eyes that there is a great strain on the muscles that turn the eyes inward; for the closer an object is to the eyes, the more must the eyes be turned inward to focus both of them on it at the same time. Keeping the work close to the eyes is

FIG. 96. A good light while reading is important.

especially injurious in the case of little children; for their eyes are soft and easily pulled out of shape, and the muscles tugging at the eyes to turn them inward spoil the shape of the globe of the eye and cause astigmatism. To prevent this, school books for young children ought to be printed in type large enough so that the children will not have to keep the books close to their eyes while studying, and schoolrooms should be well lighted. The rule in erecting modern school buildings is to allow from one sixth to one fourth as much space for windows as there is floor space in the room. Ribbed glass used in the upper sashes assists very greatly in spreading the light evenly over the room.

**Resting the eyes helpful and overtaxing them injurious.** When we have been reading or doing other close work for some time, it benefits the eyes greatly to stop for a few moments and look at a distant object, or to gaze into the distance without looking at anything in particular. Reading on a moving train or a street car quickly tires the eyes, because the distance between the book and the eye is constantly changing, and the muscles in the eye are kept busy changing the shape of the lens. Reading while lying down is also hard on the eyes, because the book or paper is often held in such a position that the eyes must be strained to see it. If you read while traveling or while lying down, rest your eyes occasionally and stop the reading before the eyes have become fatigued.

## QUESTIONS

How are the eyes protected from blows? from light and dirt? Where are the glands which secrete the tears? Of what use are the tears? What is the cause of scales on the edges of the eyelids? Explain how the eye is moved. What causes a person to squint? Name the coats of the eye. Describe the cornea; the lens; the aqueous humor; the vitreous humor; the iris; the pupil. In what part of the eye are the nerves of sight?

Explain how images are formed in a camera and in the eye. In what do the images in the eye start messages? What judgments does the brain form from these messages?

How is the eye accommodated to near and far objects? What causes near-sightedness? far-sightedness? astigmatism? What is the effect on one's health of a blurred image on the retina? How many school children in the United States need

glasses? Why is it important, aside from improving the health, that glasses be worn by children who need them?

In what germ diseases are the eyes infected? How should the eyes be cared for in these diseases? What is "pink-eye"? "granulated lids"? Name some things that should be avoided because they may allow germs to enter the eyes.

From what direction should the light come when one is working? Why is it harmful to read or work by a dim light? Why is work that is held close to the eyes especially harmful to little children? How much window space should a schoolroom have? Why is it harmful to read on a moving train? while lying down?

### SUGGESTIONS TO THE TEACHER

When medical inspection is lacking, the school should have a vision chart for examining the eyes. This is usually furnished free by city and state superintendents, or a copy may be bought for ten cents from Eyesight Conservation Council, Times Building, New York City. The following directions will allow a rough test to be made with the letters on page 329: —

Have a good light on the letters that are to be read. Seat the pupil at a distance of 20 feet from them. Test persons wearing glasses with their glasses on. Cover one eye with a card (but do not press on it) while the other is being tested.

The upper line should be read at a distance of 30 feet and the lower lines at a distance of 20 feet. In case either eye fails to measure up to this standard, glasses are needed. Persons who cannot read may be tested by asking them whether the letter E in the chart is open at the right, left, top, or bottom. In case the pupil knows the chart by heart, cut a small opening in a piece of cardboard and expose only one character at a time while the test is being made.

Failure to read the letters by children under seven years of age does not necessarily mean that glasses are required.

There may be defects of the eye that will not be revealed by this test. When there are symptoms of eyestrain, an eye specialist should be consulted. Directions for using the vision chart will be found on it.

# CHAPTER THIRTEEN

## THE EAR

FIG. 97. The light waves start impulses in the nerve of sight, and we see the lightning; the sound waves start impulses in the nerve of hearing, and we hear the thunder.

DOUBTLESS you have seen a flash of lightning fall from the sky, and have stood and waited until the rolling of the thunder came to your ears. What was it that came to your eyes and caused you to see the lightning? It was waves in the ether.[1] What was it that came to your ears and caused you to hear the thunder? It was waves in the air. Why can you not see the thunder? It is because the eye is not affected by waves in the air; only ether waves can stimulate the nerves of sight. Why is it that you do not hear the lightning? It is because ether waves do not affect the ear; only air waves stimulate the nerves of hearing.

[1] Ether is an invisible, elastic fluid that fills all space. Light, the electric waves that are used in wireless telegraphy, and the X-ray are waves in the ether. They run with almost incredible speed, light traveling at the rate of 186,000 miles a second. Air waves are very much slower than ether waves, sound waves traveling only about 1120 feet a second.

Through the ear the confusion of air waves that comes from the instruments of an orchestra is transformed into music; through it we are able to understand the thoughts of a friend when he, by speaking, sends a series of air waves to us across a room. In the whole body there is nothing more wonderful than this instrument that has been given us to catch the waves in the air and carry their motion to the nerves of hearing, which lie deep in the bones of the skull.

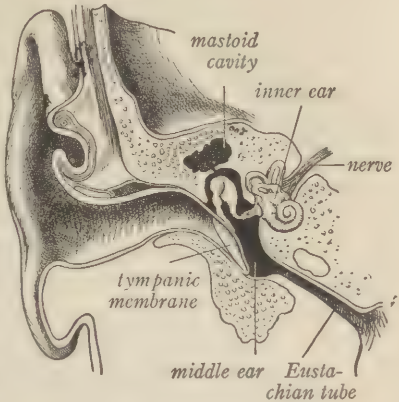



FIG. 98. Diagram of the ear.

There are three main divisions of this organ, — the *outer*, the *middle*, and the *inner* ear.

**The outer ear**. The outer ear is composed of cartilage covered with skin. It catches the sound waves and turns them down a winding canal to the middle ear. When a dog, a horse, or a rabbit is listening, it holds up its ears to catch the sound waves, and a man sometimes puts his hand behind his ear to help in catching the sound and turning it into the ear.

**The middle ear**. The middle ear is a little drum-shaped cavity in the bone of the skull. It is filled with air, and is connected with the throat by the Eustachian tube. At the inner end of the canal that leads inward

from the outer ear is a little membrane called the *tympanic membrane.* This stretches like a thin skin across the bottom of the canal and separates the outer ear from the middle ear.

The bone of the skull behind the middle ear is spongy and has a cavity in it which is called the *mastoid cavity.* This opens out, like a little chamber, from the middle ear, and when germs infect the middle ear they often reach the mastoid cavity also. This trouble is called *mastoiditis.* In cases of this disease there is always danger that the germs will find their way to the brain and cause meningitis.

**The bones of the ear.** Across the middle ear a chain of three small bones stretches from the tympanic membrane to the inner ear. These bones are called from their shape the *malleus* (hammer), the *incus* (anvil), and the *stapes* (stirrup). The malleus is fastened to the tympanic membrane; the stapes fits into an opening that leads into the inner ear; and the incus is between the malleus and the stapes (Fig. 99). After we have studied the plan of the whole ear, we shall learn how these bones carry the motion of the sound waves from the tympanic membrane to the inner ear.

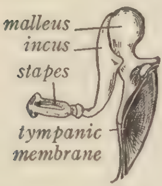



FIG. 99. The chain of bones of the ear connecting with the tympanic membrane.

**The inner ear.** The inner ear lies deep in the bone of the skull. It is exceedingly complicated in structure and we shall not attempt to explain it further than to say that it has three parts, — a central part called the *vestibule*, a coiled part called the *cochlea*, and three *semicircular canals* at the back that wind through the

bone of the skull. The entire inner ear is filled with a fluid, and the fibers of the nerve of hearing end in such a way that when waves are set up in the fluid, the nerve endings are stimulated and messages are started in them to the brain.

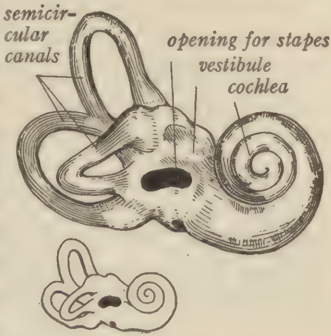


FIG. 100. The inner ear. The lower figure shows the natural size of the inner ear.

**How a sound wave starts a message to the brain.** When a sound wave strikes the outer ear, it is turned down the canal leading to the inner ear; it then strikes against the tympanic membrane and starts it to swinging out and in. This puts the malleus, the incus, and the stapes in motion, and the stapes is pushed in against the liquid in the inner ear. This sets up waves in the liquid, and the beating of these waves stimulates the nerves of hearing and starts messages to the brain. When these messages reach the brain, we hear the sound.

If the waves in the air are large and strike violently against the tympanic membrane, so that large waves are set up in the fluid in the ear, we say that the sound is loud. If the waves are small, so that the tympanic membrane and the chain of bones swing gently to and fro, the nerves are stimulated only a little, and the sound is soft. Within the inner ear is a wonderful mechanism which is so arranged that a sound having one pitch will start messages in one set of nerves, and a sound having a different pitch will start messages in another set of

nerves. By this arrangement the brain is able to tell the pitch of the different sounds that come to it.

**Earache and running ear.** Practically all ear troubles are in the middle ear and are caused by germs. These germs work their way from the throat into the ear through the Eustachian tube, and they grow in the lining of the middle ear and about the little bones, much as they grow in the nose when we have catarrh. Frequently, in diseases like colds, grip, scarlet fever, measles, and diphtheria, the ears become infected, and in these cases it is most important that a physician give them early and proper care. Often it is adenoids that start ear trouble, and in chronic cases of earache or running ears, adenoids should be looked for.

It is not right to allow children to suffer needless pain from ear troubles, and they ought not to be left to outgrow them; for a running ear already has a hole through the tympanic membrane, and the hearing is in danger of being lost. Nearly all deafness in older persons is due to the fact that when these persons were children, germs were allowed to grow in the ears until they damaged the tympanic membrane or the bones that carry the motion of the sound waves to the inner ear. Sometimes the membrane or the chain of bones is broken down or destroyed. Sometimes the trouble is that the membrane is thickened and stiffened, or the chain of bones is stiffened at the joints until the movement in it is wholly or partly lost. Among grown persons about one third have the hearing affected in one or both ears. This could be prevented by attending to the ears at the proper time.

**Other points in the care of the ear.** Quinine, if taken

for a considerable time, may cause deafness, and this medicine, like other medicines, should be used only when prescribed by a physician. A blow on the side of the head is dangerous to the hearing; for it may send so strong an air wave down the canal of the ear that the

FIG. 101. Testing the hearing.

tympanic membrane may be broken. Live insects in the ear cause great distress by buzzing and moving about. They should be drowned by pouring warm water into the ear.

No one but a physician should attempt to remove objects from the ear, because an unskilled person in attempting to do so may injure the lining of the canal, or break the tympanic membrane. In the canal of the ear there is a bitter wax secreted to protect the ear from insects. Children sometimes form a habit of picking at their ears with the head of a pin or other object. This causes the lining to become inflamed and the wax to be secreted too abundantly. One physician has said, "You should never thrust anything smaller than your elbow into your ear," and another has added, "Before you thrust your elbow into your ear you should wrap your coat around it." If wax accumulates until it becomes troublesome, a physician should be consulted.

### QUESTIONS

Describe the outer ear. What is its use? Describe the middle ear. What separates the middle ear from the outer ear? What is the mastoid cavity? What causes mastoiditis? Name and describe the three bones of the middle ear. Where is the inner ear? Name its parts. With what is the inner ear filled?

Where do the nerves of hearing end? Explain how a sound wave stimulates the nerves of hearing. What is the difference between a loud sound and a soft sound? Explain how it is possible for the brain to understand the pitch of a sound.

How do germs enter the ear? In what parts of the ear do they grow? What is the most common cause of earache and running ears? What is the cause of nearly all cases of deafness in grown persons? What per cent of adults have impaired hearing?

What bad effects have excessive doses of quinine? Why is a blow on the side of the head dangerous? What damage may be done when an unskilled person attempts to remove objects from the ear? What is the use of the bitter wax in the ear? What damage may be done by picking at the wax in the ears?

### SUGGESTIONS TO THE TEACHER

In schools that do not have medical inspection the teacher should test the hearing. This may be done either with a watch (Fig. 101) or by requiring the pupil to repeat words that have been whispered to him. Each ear should be tested separately. It should be impressed upon the pupils that deafness is rarely curable and that any ear trouble demands medical attention at once.

# CHAPTER FOURTEEN

## THE ORGANS OF TOUCH, TASTE, AND SMELL

THE sight and the hearing are especially important because they give us knowledge not only of near objects, but also of objects that are far away. The sense of smell may also give us information of an object when it is at a distance; but in the main this sense, as well as the sense of taste and the sense of touch, is valuable because it enables us to judge of objects that are near at hand.

FIG. 102. A blind girl reading by sense of touch.

There is not much that we can learn about any of these senses that is important from the standpoint of health. It is interesting, however, to know something of the way in which the messages that cause the sensations of touch, taste, and smell are started in the nerves, and to understand something of what we learn through these senses. In this chapter we shall therefore study the organs of touch, taste, and smell.

**Touch.** The sense of touch is the most widely distributed of all the senses, for we can feel through the skin on every part of the body. Through the sense of touch, even better than through the eye, we can learn the form of objects; through it we can tell whether objects are smooth or rough, whether they are hot or cold.

Blind persons learn to read by passing the finger tips over raised letters, and persons who are both blind and deaf gain through the touch much of the information that comes to others of us through the eye and ear. The touch, therefore, is a sense that is not only at all times highly useful to us, but one that can be further educated and in time of need called into use to take the place of other senses.

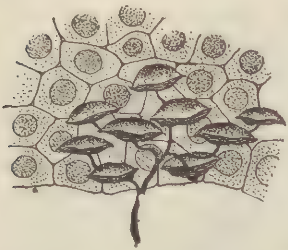


FIG. 103. A nerve fiber ending around the bases of the cells in the epidermis.

**The endings of the nerves of touch in the skin.** The dermis, or lower layer of the skin, is thrown up into little peaks called *papillæ* (singular, *papilla*) that stand up under the epidermis. Some papillæ contain a great network of little blood vessels. Others contain a *touch corpuscle*, which is a little group of cells with a nerve fiber winding about through it and ending in it (Fig. 76). Other fibers of the nerve of touch divide at the outer end into many little branches which end freely among the lower cells of the epidermis, or spread out into little saucer-like structures around the bases of some of these cells (Fig. 103).

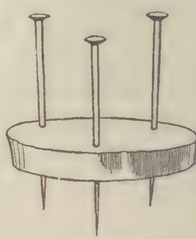


FIG. 104.

The nerves of touch are especially abundant in the fingers, lips, tongue, and tip of the nose, and in these places the sense of feeling is most acute. You can perform some interesting experiments by thrusting two or three pins through a piece of cork or wood

(Fig. 104) and trying how far apart you must place them on different parts of the body to enable you to feel the points of the pins separately.

**Messages started by pressure in the nerves of touch.** When we touch anything, the epidermis is pressed down on the ends of the nerves of touch. This starts impulses to the brain, and when these impulses arrive in the brain they cause us to feel. If all the nerve endings that are being stimulated have the same amount of pressure on them, we know that we are feeling a smooth surface. If some of them are being pressed harder than others, we know that the surface is rough. When we are touching an object, we know where the object is, because we know from what part of the body the messages are coming. We know whether the object is large or small by the extent of skin surface that is touching it, and by the distance that we must move our hands to pass them over it. If you lay your hand against the wall, messages come in from the whole front of the hand, and you judge that you are touching one large object. If you feel two objects, like the points of two pencils, you know that there are two of them because the messages come from two places in the skin with a space between them in which the nerves are not being stimulated.

**Mistaken judgments concerning objects that we touch.** The mind can make mistakes in judging of the messages that come in through the nerves of touch as well as in forming judgments from the messages that come in through the eye. Cross your fingers and rub them across the tip of your nose so that the nose is between the two fingers. Can you explain why you seem to feel two noses?

**Taste.** The nerves of taste are in the mucous membrane of the tongue and of the back part of the mouth. Before anything can be tasted, it must first be dissolved. Then it works its way down among the cells and starts impulses in the nerves of taste. When these impulses reach the brain, we learn whether the object has a sweet, sour, bitter, or salt taste. Many of the supposed tastes of foods are in reality odors, and when because of a cold or for other reasons the sense of smell is dull, many foods are practically tasteless. The continual use of tobacco, alcoholic drinks, and strong condiments like pepper and tabasco sauce, permanently diminishes the sense of taste.

**The sense of smell.** The sense of smell is probably the keenest of all our senses. It is likely that it is of use chiefly to judge whether or not our food is in proper condition to be eaten, and to tell whether air is fit to be breathed. Lower animals, like the dog, have this sense so highly developed that they can follow the track of a man or other animal many hours after the trail has been made. Among men, individuals differ greatly in the sharpness of their sense of smell.

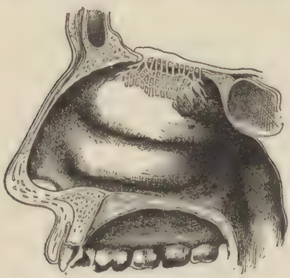


FIG. 105. The nerve of smell ending in the mucous membrane of the nasal chamber.

**The nerve of smell stimulated by particles in the air.** What we call an odor, or a smell, is in reality little particles of matter floating in the air. These particles come from a rose, from our food, or from anything that we smell,

and are drawn up into the nasal chambers with the air. In the mucous membrane that lines the upper part of these chambers are found the *olfactory cells*, from which nerve fibers run to the brain. When odors come in contact with the olfactory cells, impulses are started that cause the sensation of smell.

**Care of the organ of smell.** When the delicate olfactory cells are destroyed, they are not renewed, and the sense of smell is permanently lost. They may be destroyed by inflammation, which is often brought on by inhaling dust or by working among the fumes of acids or other chemicals. Exhaling cigarette smoke through the nose is also very injurious to the cells, and many cigarette smokers have little or no sense of smell. Another common cause of the loss of the sense of smell is catarrh, which ought always to be treated by a good physician and not allowed to run on from year to year. When the throat is blocked by adenoids, the odors of foods cannot enter the nose as they should, and the pleasure of eating is to a considerable extent lost. The sense of smell is valuable to us both because of the pleasure that we receive from agreeable odors and because of the warnings that come to us in the way of disagreeable odors, and we ought to try to keep it in as good working condition as possible.

## QUESTIONS

What do we learn through the touch? What is a papilla? Explain how the nerves of touch end in the skin. Where are the nerves of touch most abundant?

When we touch an object, how are the impulses started in the nerves? How do we judge whether an object is rough or

smooth? How do we know where it is? How do we judge of its size?

Where are the nerves of taste? How does the food reach the nerves of taste? Why can we not taste certain foods when we have a cold? How may the sense of taste be injured?

What purpose does the sense of smell serve? What is an odor? Where are the nerves of smell? How are messages started in them? How may the sense of smell be injured?

### SUGGESTIONS TO THE TEACHER

If the class has time for them, it will add interest to the work to perform a few simple experiments in touch, taste, and smell. Directions may be found in any text of experimental psychology. Optical illusions also are interesting and they bring to the attention of the pupil the part played by the brain in sensation.

In Figure 91 the iris may appear to be seen from either front or back, and other optical illusions may be found in texts of psychology or more advanced physiology. Common illusions that may be called to the pupil's attention are: the fact that the letter s and the figure 8 must be made larger at the bottom to prevent their seeming heavier at the top; that the sun and moon appear larger on the horizon than when high in the sky; that from a railway train the landscape seems to be moving; and that when one looks at the moon through the treetops while running, the moon seems to run with him.

# CHAPTER FIFTEEN

## FOODS AND WHY WE NEED THEM

FIGS. 106 and 107. The windmill gets its power to work from the wind which blows against it; the man gets his strength from the food that he eats.

FROM my window I can see a windmill standing with its arms outlined against the sky. A little while ago it was whirling rapidly about and pumping water into the tank that it keeps supplied. Now it is standing motionless in the sunshine, as if overcome by the morning heat. Is the windmill broken? Or has anything happened to it that will keep it from any longer pumping water for its owner? Not at all. The only trouble is that the wind which supplied the *power* to run the mill has for the time failed.

Wherever there is motion and whenever work is done, power to cause the motion and to do the work must come from somewhere. We think of a swift and heavy automobile as a powerful machine, but in reality the power comes from the gasoline that is exploded in the cylinders, and when the supply of gasoline gives out, an automobile can no more move itself than can a stone. Every other machine, whether it be run by

steam, gasoline, electricity, water, wind, or in any other way, must draw the power that runs it from some source outside itself. The windmill cannot run itself; it must stand and wait until the wind comes to give it motion and make it able to do its work.

**Food as a source of power.** The human body has strength. It moves and does work. It cannot furnish itself with power, however, so we must have some source

FIGS. 108 and 109. Food is necessary to furnish material for the repair and growth of the cells, and to keep up the body heat.

from which to draw the strength that is in our muscles. This source of power is the food that we eat. *Food is necessary to give strength to the body.* Without it the muscle cells cannot contract and cause the movements of the body parts.

**Food as fuel.** A locomotive as it thunders past us glows with warmth. It gets its warmth from the fuel that is burned under its boiler. A stove with a fire in it gives off heat to all the room. This heat comes not from the stove itself, but from the fuel that is burned in the stove. Your own body is warm, as you know from

feeling it. The heat of the body comes from the food that is burned within the cells. *Food is necessary to keep up the body heat.* Without it the temperature of the body would quickly fall to that of the air about it, and this would be fatal to the cells; for, as you already know, the cells can live and be in health only when the temperature of the body is close to 98 degrees (page 295).

**Food as building material**. The human body is more wonderful than any machine made by man in that it builds its own parts and keeps them in repair. The body starts as a single cell, which is composed of *protoplasm*, or living material. This cell builds more protoplasm, increases in size, and divides, and this process is kept up until the full-grown body is finally built of living cells which have come from the first cell. Even after the body is grown, new cells must be built; for as long as life continues, the outer cells of the skin, the red blood corpuscles, and some of the other cells are dying and being replaced by new cells.

New protoplasm is also constantly needed to repair the cells; for within all the cells the living protoplasm is constantly breaking down and new protoplasm is being built to take its place. The material that is used in all this building of living matter comes from the food that we eat. *Food is necessary to furnish material for the growth and repair of the cells.*

**Elements found in the body**. The living matter of the body is composed of at least five different elements, all built together into a material that is very different from any of them. The black solid called carbon makes up over one half of the whole. The two gases of the air, oxygen and nitrogen, together with another

very light and highly explosive gas, called hydrogen, make up nearly all the remainder. In addition, some sulfur is built into protoplasm, and in the nucleus of the cell a little phosphorus is found. Among other elements that are present in the body are chlorin and five minerals, — potassium, sodium, calcium, magnesium, and iron. It is not intended that you shall remember the names of all these elements, but it is intended that you shall understand that the body is made of perfectly definite materials, and that if these materials are not supplied in our foods, the body must suffer.

**The three classes of foods.** Foods are divided into three classes, according to the elements of which they are composed. These classes are the *proteins*, the *carbohydrates*, which include the starches and sugars, and the *fats*. Lean meats, eggs, milk, peas, beans, and all foods made from grains are rich in protein. Potatoes, turnips, cabbage, and other vegetables are valuable mainly for their starch. Grains also contain large amounts of starch. Fruits, sweet potatoes, honey, molasses, and milk contain sugar, and we add great quantities of sugar to our foods to make it more pleasant to the taste. Fats and oils we get in butter, lard, fat meat, eggs, cheese, chocolate, nuts, and olive and cottonseed oil. In general, we get proteins and fats from animals, while from plants we get proteins and carbohydrates. From the table on page 482 you can learn the relative amounts of carbohydrates, fats, and proteins in different foods.

**Proteins the building foods.** All three classes of foods give heat and strength to the body. The proteins furnish building materials in addition. They contain the

same five elements that are found in the living matter of the body, — carbon, hydrogen, oxygen, nitrogen, and sulfur. Since they are used for building up the cells, we should expect them to contain these elements; for we use leather to patch a leather shoe, steel to replace a worn-out part in a machine, and to repair the body, the materials of which the body is built must be used.

**Minerals necessary to the body.** A man excretes from his body nearly an ounce of mineral salts daily,[1] and it is

FIG. 110. Wild animals often travel long distances to salt-licks. Man supplies himself with salt, but he often lacks other minerals.

necessary that certain amounts of the different minerals found in the body be supplied to make good this loss. In our food we always get small quantities of these minerals, and little attention has been given to making sure that diets include a sufficient supply of them. Recent experiments show that this trusting to chance for the right amount of minerals is not always satisfactory. Not counting common salt, with which we all supply ourselves, the three minerals that may be lacking in our

[1] The greater part of this mineral matter is common salt, of which the average man uses daily from one third to two thirds of an ounce. This is more than is necessary for the health, for experiments indicate that one tenth of this amount is sufficient to keep the body in good condition.

food are *iron*, *calcium* (lime), and *phosphorus*. We shall discuss the need for each of these separately.

**Iron needed to build red blood corpuscles.** Iron is used in the body mainly in building *hemoglobin*, the substance in the red blood corpuscles that carries the oxygen. If the supply of iron falls too low, the person becomes pale and weak because of a lack of red corpuscles and because of a lack of hemoglobin in the corpuscles that he has. In cases of this kind the patient is given iron in liquid form as a medicine, and a little of this seems to be used by the body; but all physicians agree that for building hemoglobin the iron in food is far more valuable than iron in other forms.

The green parts of vegetables, especially spinach, are rich in iron; and, in general, eggs, vegetables, and grains, when the outer portion of the grain is used, give a rich supply of this mineral. Milk is low in iron, and in animals that feed their young on milk a large surplus store of iron is laid up in the body before birth. It is estimated that fifteen milligrams of iron are needed daily by a healthy man, and that the average diet contains from twelve to nineteen milligrams.[1] This indicates that it would be very easy to select a diet that would be deficient in this important mineral.

**Lime needed by the body.** Careful investigation has shown that growing animals require about 1.2 per cent as much calcium as they gain in weight. When this amount of calcium is not provided, the bones are frail and the teeth are soft and defective. There must also be a certain amount of calcium dissolved in the

[1] An ounce of iron would furnish the body with 15 milligrams a day for five years.

lymph to keep the cells in health, and if the supply of lime be cut off entirely, life cannot continue. It is claimed that one half the people of the United States are suffering from lime starvation, and it is certainly true that many young children are not supplied with enough of this mineral. Adding a little limewater to artificial foods does not provide enough lime to be of much importance in building the skeleton and the teeth; for a pint of limewater as strong as it can be made contains slightly less lime than is contained in a pint of cow's milk. Milk, eggs, vegetables (especially leaf vegetables), and whole grains hold the first place among the foods that are rich in lime (page 482).

**Lack of phosphorus in the body**. Experiments indicate that from 65 to 90 milligrams of phosphorus are needed daily in the body, — an amount greater than many diets will supply. The yolk of egg, the outer layer of grains, peas, beans, chocolate, and nuts are especially rich in phosphorus. Meats also supply considerable quantities of this element to the body. Larger amounts of phosphorus are needed during the growing period than in adult life, and if this is not supplied the bones are likely to become soft.

**Foods rich in minerals**. It is perhaps worth while to call attention at this time to the fact that the foods on which young animals live while starting in the world supply minerals as well as protein and energy-yielding substances to the body. Milk has in it all the elements, except iron, that are necessary to nourish a young animal, and an egg has in it everything necessary to build a chick, including the iron for the blood corpuscles and the lime for the skeleton.

Foods which are rich in minerals ought to form a great part of our diet and be eaten by young people especially. Vegetables, also, because of the large quantities of them that can be eaten, furnish a rich supply of minerals to the body. In the body of an animal the lime is in the skeleton, and when we eat the meat we

FIGS. 111 and 112. Eggs and milk contain all the elements necessary to start a young animal on its life.

get little of this mineral.[1] In wheat the mineral matter is mainly near the surface of the grains and is not found in white flour.[2] A diet, therefore, that is composed chiefly of meat and white bread is low in the minerals needed by the body. Whole wheat bread, oatmeal, breakfast foods, and, in general, vegetables and fruits, are rich in minerals. Children who are fed too long on milk suffer because of a lack of iron, and a meat diet supplies less mineral to the body than a vegetable diet. The diet of children in particular needs

[1] When a wolf or a fox eats a bird or a hare, it makes sure of a supply of calcium for itself by eating the bones as well as the flesh. Puppies fed only on lean meat and fat meat showed weakness of the bones, while other puppies of the same litter that were given bones to gnaw, in addition to the meat, developed normally.

[2] The laxative effect of whole wheat bread is now believed to be due to the rich supply of phosphorus in it, and not to the irritating effects of the bran, as was formerly supposed.

care to make sure that the right minerals are contained in it, for there is a special need for mineral matter when the body is growing rapidly. Generally speaking, the mineral income of the body can be increased by cutting down the amounts of meat and white bread eaten and using milk and vegetables more freely.

**Vitamins**. Within the last few years it has been discovered that certain substances called *vitamins* are necessary for health. We do not know exactly what vitamins are, but small amounts of them are found in our foods, and a good diet must contain them. They are destroyed by cooking with alkalis, and are therefore not found in corn bread or in biscuit made with soda.

We are not sure how many vitamins there are, but two are definitely known to exist. One is present in whole grains, in beans, peas, potatoes, turnips, and other vegetables, and in milk and eggs. In our country almost every one secures enough of this vitamin, but the lack of it causes a disease of the nervous system called beriberi, which is responsible for many deaths among peoples who live chiefly on rice. The second vitamin is found in milk and butter, the yolk of eggs, and the green parts of vegetables. When animals are given a diet that contains none of this vitamin, growth does not take place and there is soreness of the eyes; and when the supply of vitamin is low, growth is slow and the health is poor. Many persons in our country do not get enough of this vitamin, and one of the chief reasons for the use of leaf vegetables and milk is to secure an abundant supply of it.

**Selecting foods**. Of all the hygienic problems that confront mankind, that of selecting a proper diet is one

of the most difficult. Since the health of the digestive organs must be kept in mind as well as the needs of the body for certain materials, the whole subject can be entered into more intelligently after the digestive system has been studied. In the next chapter, therefore, we shall discuss the digestive organs and their work, and shall then take up the more difficult subject of selecting a diet that will keep the human body in health.

## QUESTIONS

Give three uses of foods in the body. Name the five elements that make up most of the body tissues. Name some other elements which are present in the body. Name the three classes of foods. What foods are rich in protein? in starch? in sugar? in fat?

Which classes of foods give heat and strength to the body? Which class furnishes building material?

For what is iron used in the body? In what foods is iron abundant? Why is lime necessary to the body? What foods are rich in lime? What foods are rich in phosphorus? Why are milk and eggs complete foods? Why is a diet of meat and white bread deficient in minerals?

What are vitamins? What diseases are due to a lack of them? In what foods is each vitamin found?

## SUGGESTIONS TO THE TEACHER

Sherman's *Chemistry of Food and Nutrition* (Macmillan) gives tables of food analyses, an excellent general treatment of nutrition, and a particularly full treatment of the mineral constituents of the diet. McCollum's *The Newer Knowledge of Nutrition* (Macmillan) is a new book treating the subject from a very practical point of view.

# CHAPTER SIXTEEN

## THE DIGESTIVE ORGANS AND THEIR WORK

Robinson Crusoe on his island had plenty of goats, and from goat hair a fine waterproof cloth is woven that is used as a covering for the tops of automobiles. Yet, because Crusoe had no way of turning the hair of his goats into cloth, he was forced to wear clothes made of stiff, heavy skins and to carry an absurdly heavy and awkward skin umbrella. There were trees in abundance on the island, but it required much labor to convert them into baskets, furniture, and boats. There was clay from which all kinds of dishes and vessels could have been made, but he went for years without tasting soup or boiled food, and he counted it one of the happy hours of his life when he succeeded in making a rude vessel that would stand the fire. There were tons of sand to be had from which glass might easily have been manufactured, but he had no windows in his dwellings. All about Crusoe were materials from which a thousand articles could have been made that would have added to his comfort and enjoyment, but until these materials were worked over and changed, he could not put them to use.

The meats, grains, and vegetables that we eat contain the materials that are needed for the nourishment of our bodies, but the form of these foodstuffs must be changed before we can use them. As ice must be melted before the elements that are in it can be used by the body, so must our foods be *digested* before they can be taken into the blood and used by the cells. *Digestion is the process of breaking up and changing our foods into*

*substances that can be dissolved and taken into the blood.* Until this is done, our solid food is as useless to us as were most of the materials on his island to Robinson Crusoe.

**The digestive system.** The digestive system includes the *alimentary canal*, the *teeth*, the *salivary glands*, the *liver*, and the *pancreas*. The alimentary canal is the long passageway through the body into which the food is taken and in which it stays while it is being digested. It is lined with a smooth mucous membrane, and in its walls are muscles to force the food onward through the canal. The teeth are a mill set at the mouth of the alimentary canal to crush and grind the food into small pieces so that it will be easier to digest. The other digestive organs are glands that pour juices into the alimentary canal to assist in the digestion of the food. The whole process of preparing the food for the use of the body is a most

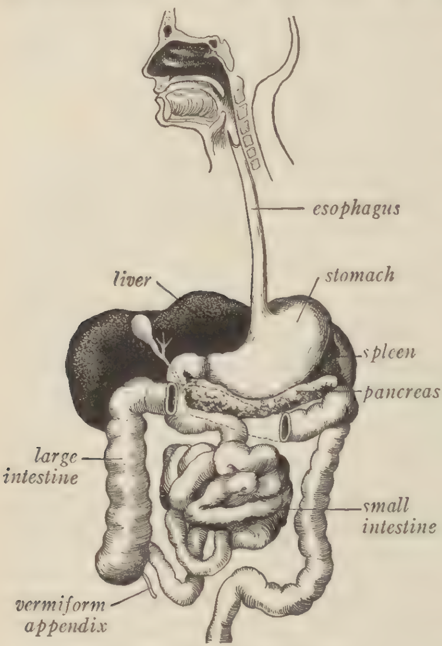


FIG. 113. The digestive system.

important one, and the great set of organs that carry it on fill nearly the whole abdominal cavity.

**The digestive glands.** The digestive glands are formed by the folding of the mucous membrane that lines the alimentary canal into deep little pockets. The juices that digest the food flow out of the mouths of these glands. The liquid part of the juices is composed of water that passes through the walls of the glands from the lymph, as water passes into a sweat gland (page 297). Some glands are simple, like little wells sunk in the walls of the digestive tract. Others, like the salivary glands and the pancreas, are branched like a tree, and the juices that come from them are secreted by hundreds of little tubules, all of which flow into the main duct of the gland. The glands are said to *secrete* when the liquid flows from them, and the liquid itself is called the *secretion* of the gland.

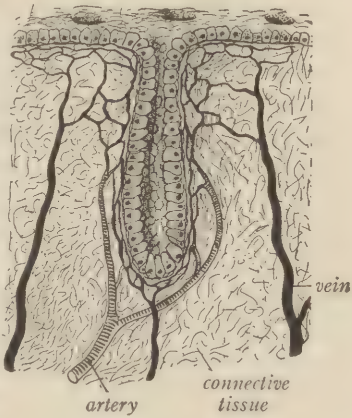



FIG. 114. Diagram of a simple gland.

**The work of digestion done by enzymes.** Dissolved in the secretions of the digestive glands are certain substances called *enzymes*. These are built up by the cells that compose the walls of the glands and are dissolved by the liquid which passes through the cells when the glands secrete. *The work of digesting the foods is done by the enzymes.* An enzyme digests only

one kind of food, so there are different enzymes secreted for breaking up the protein, fat, starch, and each of the different kinds of sugars that we eat. As we study the work of the different digestive juices, we shall speak of them as digesting the foods. You will understand, however, that it is the enzymes in these juices that do the actual work of digestion.

**The salivary glands**. There are three pairs of salivary glands. One pair lies under the tongue; one pair is found under the corners of the lower jaw; and the other pair is found in front of and below the ears (Fig. 115). These glands secrete the saliva, which is carried to the mouth by ducts leading from the glands. The saliva moistens the food and makes it possible to swallow food like crackers, which in a dry state would become dust in the mouth. Dissolved in the saliva is an enzyme which begins the process of digestion by attacking the starch that is in the food and breaking it up into malt sugar.

FIG. 115. The salivary glands.

**The esophagus and stomach.** The esophagus is the tube connecting the throat and the stomach. Food and drink do not fall down the esophagus, but are forced down it by the contraction of the muscles in the walls of the esophagus. This you can prove by drinking with your head lower than your body.

The stomach stands almost on its end on the left side

of the body close up under the diaphragm. It holds about three pints, and when full is about a foot long. When empty, its walls are drawn together and it occupies little space. It has a double function — to serve as a storehouse for food so that enough can be eaten at one time to supply the body for several hours, and to secrete *gastric juice* for the digestion of the food.

**The gastric juice.** From two and one half to five quarts of gastric juice are secreted a day. It comes from the many hundreds of little glands which lie in the stomach wall and open into the stomach. The gastric juice contains an enzyme called *pepsin* that digests protein. It contains also an acid which kills many of the bacteria in the foods and so keeps these bacteria from causing trouble in the intestine. The acid in the gastric juice stops the action of the saliva on the starch, but in the upper part of the stomach the food may lie from one to two hours before the gastric juice works its way through it. The saliva, therefore, has a considerable time in which to digest the starch before the acid reaches it. The heat in the stomach melts the fat in the food, which assists in reducing the whole food mass to a liquid condition.

**The small intestine.** The small intestine is coiled and folded upon itself in the abdominal cavity. It is about twenty-two feet in length and its walls are lined with thousands of little glands. These glands secrete an intestinal juice which contains several enzymes that are important in the digestion of the food. On the intestinal wall are many little finger-like projections called *villi* (singular, *villus*). These contain many blood vessels, and they *absorb* the digested food; that is, they

take it into the blood through the intestinal wall. So abundant are the villi that they give the entire inner surface of the intestinal wall the appearance of velvet.

**The liver and the pancreas.** The liver weighs nearly four pounds and is the largest gland in the body. It lies on the right side of the body under the diaphragm. It secretes a greenish yellow liquid called *bile*, which is poured into the small intestine when food passes into the intestine for digestion. The bile assists in destroying acids that come from the stomach, in making more active the enzyme that digests the fats, and in dissolving the fatty foods. In the next chapter, we shall study other important functions of the liver.

The pancreas is a long, light-colored gland which lies along the lower border of the stomach. It secretes and empties into the small intestine great quantities of thin, watery *pancreatic juice*. This liquid contains enzymes for digesting the three most important foodstuffs, — proteins, starches, and fats. The pancreatic and intestinal juices along with the bile are thoroughly mixed with the food in the small intestine, and they are even more important than the gastric juice in preparing the food to be carried to all parts of the body.

**The large intestine.** The large intestine begins low down in the right side of the abdominal cavity, passes up the right side of the body, then across under the diaphragm, and down the left side of the body. Just below where the small intestine opens into it, there is a small, worm-like structure called the *vermiform appendix*. The walls of the vermiform appendix contain much loose spongy tissue of the same kind that is found in the tonsils, and just as tonsillitis is caused by germs growing in

the tonsils, so appendicitis is caused by germs growing in the walls of the appendix.

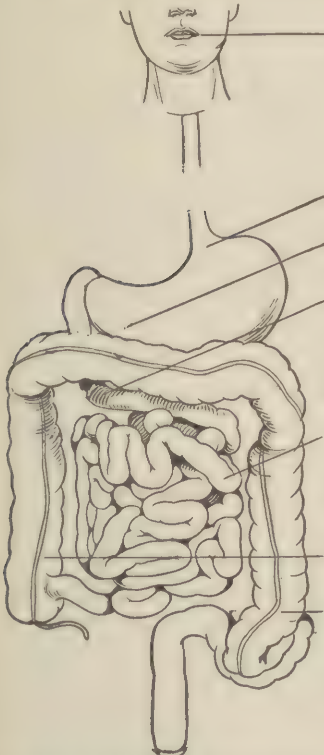



FIG. 116. A diagram illustrating the changes that take place in the food during its journey through the different parts of the alimentary canal.

**The story of digestion.** Let us now trace the history of a meal by imagining that we can see the food after it has been eaten, and that we can watch it while it is being digested. In the mouth we find that the teeth slide over

each other, crush the food into small pieces, and mix it with saliva. The enzyme in the saliva at once begins the process of digestion by attacking the starch that is in bread, potatoes, and many other of our foods, and changing it to sugar.

After the food has been chewed, the tongue draws it back into the opening of the pharynx. The walls of the pharynx then grasp it and press it backward and downward into the esophagus, through which it is carried to the stomach. When the food reaches the stomach, the gastric juice trickles in on it from the glands in the walls all about, and the pepsin attacks the meats and other protein foods. Under the action of the gastric juice the outer layer of the food mass dissolves and slides on into the lower part of the stomach, where the stomach walls contract on it and squeeze it about to mix the gastric juice thoroughly with it.

From time to time the ring of muscle that closes the gateway between the stomach and the intestine opens, and a portion of the food from the lower part of the stomach is forced on into the intestine in the form of a thick liquid.[1] Here a flood of digestive juices is poured in upon it. Greenish yellow bile comes from the liver; great quantities of juice rich in enzymes for digesting proteins, starches, and fats are secreted by the pancreas; and all along the small intestine, juices containing enzymes are poured out by the thousands of little glands that are in

[1] It should be understood that during stomach digestion the food is continuously being worked downward from the upper part of the stomach, and that from time to time it passes on into the intestine in rather small amounts. It takes about six hours for the stomach to be emptied after an ordinary meal.

the wall. The circular muscles in the walls of the intestine keep contracting on the food and cutting it up into little sausage-like segments which are continually being made, combined, remade, and moved about, thus mixing the digestive juices thoroughly with the food.[1] All the time the food is gradually being worked along the intestine and the enzymes are bringing about the following changes in it:

The pancreatic juice attacks the protein and splits that which has escaped the pepsin of the stomach; it breaks up the starch and completes the digestion of this part of the food; and it digests the fat, changing it into glycerin and other substances that will dissolve in the intestine. The enzymes in the intestinal juice assist in digesting the protein and in changing all the different sugars into the one particular sugar (grape sugar) that the body can use.

And now as we follow the food in its course through the intestine, we notice that the liquid becomes less and less in amount; that only the solid wastes remain. As some desert rivers run out over the sand and lose themselves in their own channels, so the stream of liquid food in the intestine disappears. Where is it going? It is soaking into the wall of the intestine and passing into the millions of little capillaries that run in the wall. What will be done with it? It will be carried through all the body to furnish heat and strength, and to be built into bone and muscle and nerve; for as the waterfall, even though it keep the same form,

[1] The segments into which the food is cut are about an inch long, and the contractions of the muscle rings come as often as thirty times a minute.

is made up of rapidly passing water, so our bodies, that seem to us to be the same year by year, are composed of materials that are ever shifting. The skin that we have today will, in a short while, be dead and gone, and the food that we eat today will be built into a new skin. The flesh and heart and brain of an ox are built of grass, and the human body is built of the food that we eat.

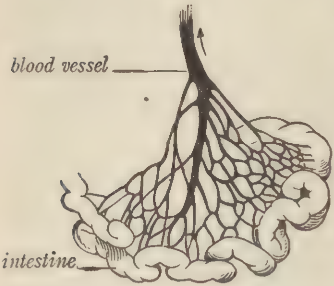


FIG. 117. Showing the vessels which carry the food from the small intestine.

**The refuse matter in the large intestine.** In all food there is some indigestible material like the woody, fibrous parts of potatoes and cabbages, the skins of fruits, and the tough fibers of meat. This matter passes from the small intestine into the large intestine, where its bulk is very considerably increased by mucus and other wastes that are secreted by the glands in the wall of the large intestine. In this waste material, millions of bacteria grow and cause decay, and in the process of decay poisonous substances are formed. Nothing is more important to the health than that this refuse material be cleared out of the intestine before the poisons are absorbed into the body. This question we shall discuss in the next chapter.

**Scurvy, rickets, and pellagra.** The causes of these diseases are not definitely known, but they are in some way connected with the nutrition of the body, and we shall discuss them in this chapter.

Scurvy is a disease in which the joints are swollen and tender and there is bleeding of the gums. It is found in infants that have been improperly fed and among sailors and others who lack fresh food. It can be prevented by fresh meats and fresh vegetables and fruits, and is relieved in a wonderful way by orange juice. Some investigators have thought scurvy to be due to the lack of a vitamin. Others believe it is caused by a bacterium that is able to enter the body when it is not properly nourished. Whatever the cause, the disease can easily be prevented by proper feeding.

FIG. 118. A milch goat.

Rickets is a disease of children in which the bones are soft. The head grows larger than is natural and becomes somewhat square, and there are knots on the ribs on either side of the breastbone where the bone and cartilage meet. It has been suggested that rickets is due to lack of a vitamin or to a lack of calcium, but neither of these explanations seems to be correct. It is in some way connected with bad feeding and is prevented and benefited by a properly selected diet.

Pellagra is common in Italy, and it is estimated that in the United States there were 165,000 cases in 1917. Most of these cases are found in the Southern states. The disease seems to spread only where the sanitary conditions are bad, and it is probably caused by a germ. At the same time, it has been proved that it is brought on by a faulty diet and that an abundant and varied diet with plenty of fresh foods will prevent it, even when sanitary conditions are bad. It seems most probable, therefore, that pellagra is caused by a germ that can attack the body only when it is in a weakened condition because of improper food.

In our Southern states pellagra is a serious problem. A great number of the persons attacked by it live, during the winter months especially, chiefly on corn bread, salt pork, and molasses; and it is very necessary that milk, eggs, and fresh vegetables be added to this diet. The garden and poultry club movements, therefore, deserve every encouragement, and the keeping of milch goats might go far toward solving the diet problem of many families. Dried milk, which seems to have all the food value of fresh milk, is now being prepared. It may be that this will prove of great value in warm regions where providing a supply of fresh milk is especially difficult. Meats will not take the place of vegetables, eggs, and milk in providing minerals and vitamins for the body (pages 353–355).

QUESTIONS

What change must be made in foods before the body can use them? What is digestion? Name the parts of the digestive system. Describe the alimentary canal. What is the function of the teeth?

Describe a gland and explain where the secretion of the gland comes from. What is an enzyme? By what is the work of digestion done?

How many salivary glands are there and where are they? What is the function of the saliva? What food is digested by the saliva? Into what is it changed?

What is the esophagus? Describe the stomach. What is the function of the gastric juice? What enzyme does it contain and what is the function of this enzyme? How are the bacteria killed in the stomach?

Describe the small intestine. What are villi? What is their function? Describe the liver. What does it secrete? What is the use of the bile? Describe the pancreas. What foodstuffs does the pancreatic juice digest?

Describe the large intestine. What causes appendicitis?

Tell the story of the digestion and absorption of food. Where is the food taken after it is absorbed?

Of what are the wastes in the large intestine composed? Why is it important that these wastes be promptly cleared out of the body?

Name three diseases that are due to an improper diet. What foods will prevent scurvy? What foods will prevent pellagra?

### SUGGESTIONS TO THE TEACHER

Additional information concerning the structure of the digestive organs and the processes of digestion may be found in Ritchie's *Human Physiology* (World Book Company, Yonkers, New York).

A fable by John W. Ritchie called *The Adventures of the Starch Family* will be found helpful in giving the pupils a concrete idea of the changes undergone by the foods during the digestive and metabolic processes. Application to the World Book Company will bring a copy of the pamphlet if four cents in stamps is enclosed.

Howell's *Textbook of Physiology* (W. B. Saunders Co., Philadelphia) is an advanced text that will furnish a wealth of physiological information on almost any subject discussed in this book. Lusk's *Science of Nutrition* (Saunders) gives a very thorough treatment of nutrition.

# CHAPTER SEVENTEEN

## THE FOODS WITHIN THE BODY

We have now traced the food through its digestion. We have explained how it is taken into the blood and carried to the cells. What do the cells do with it? What becomes of it after the cells have finished with it? Why, when we keep eating all the time, does not the body become so full of food that we cannot take in more? Perhaps it may start you to thinking about this subject in the right way if we go back for a few minutes to something else that you have seen.


FIG. 119. When the candle burns the elements in it are not destroyed.

Long ago in your Mother Goose book you read:

> "Little Nanny Etticoat,
> In a white petticoat
> And a red nose.
> The longer she stands,
> The shorter she grows."

Why does a lighted candle grow shorter the longer it stands? What becomes of the candle when it is burned? You must study chemistry before you will have a really clear idea of what happens in the process of burning. At present we can only explain to you

that the oxygen of the air unites with the elements of which the wax is composed and forms carbon dioxid and water, which pass off into the air. The materials in the candle, therefore, *are not destroyed*. They are merely changed to vapor and gas.

**The fate of the carbohydrates and the fats.** The cells of the body take in the sugar and fats of the foods. They also take in oxygen. Within the cells the oxygen and the food unite slowly and without smoke or flame, and the food is *oxidized*, or burned as truly as the wax of a lighted candle is burned. This oxidation of the foods furnishes heat to the body and strength to the muscle cells; and, as in the burning of the candle the wax is changed to carbon dioxid and water, so within the cells the fats and carbohydrates are changed to carbon dioxid and water. The carbon dioxid is breathed out of the body through the lungs. The water is excreted by the lungs, the kidneys, and the skin. Thus the fuel foods are burned in the cells and the wastes which are formed from them are cast out of the body. *The profit which the body receives from these foods is the heat and the power to do work which are given to the body when they are burned.*

**The fate of the protein foods in the body.** The living protoplasm of the body is continually breaking down and being oxidized. The protein food is used to build new protoplasm to take the place of that which is broken down.[1] In time this protoplasm will also be broken down and oxidized, so that the proteins are as

[1] It should be understood that only a part of protein food is built into living tissue. Surplus protein and even part of the protein that seems to be necessary for life is oxidized as described on page 374.

truly burned in the body as are the carbohydrates and fats. The difference is that they are built into living material before the oxidation takes place. Carbon dioxid and water are among the waste products that come from the burning of the proteins, but there are other wastes also, — *uric acid* and other similar substances. These wastes are injurious to the cells, and the liver does a very important work in gathering up and converting a great part of them into *urea*, which is excreted from the body.[1] We shall now describe the organs that eliminate the protein wastes.

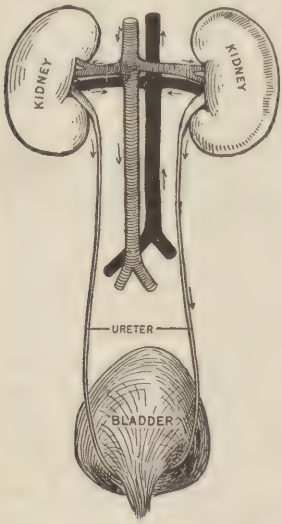


FIG. 120. The kidneys and the bladder seen from behind.

**The kidneys.** Fastened to the back wall of the abdominal cavity are two bean-shaped organs, called the *kidneys.* Each kidney has in it many thousands of little tubes which all drain into a larger tube, the *ureter* (Fig. 120). The little tubes in the kidneys, like the sweat glands, are surrounded by lymph, and the water of the lymph passes into them and flows out of their mouths, as water passes

[1] About 92.5 per cent of all the protein wastes excreted by the kidneys is in the form of urea. About 2 per cent of the whole is excreted in the form of uric acid, and it is estimated that an equal amount of uric acid is converted into urea by the liver. The uric acid part of the wastes comes from the nuclei of the cells and from the muscle cells when they work.

into a sweat gland and flows out on the skin. The urea and other protein wastes are dissolved in the lymph, and they leave the body by passing with the water through the kidney tubes into the ureter and draining off to the bladder. *The function of the kidneys is to excrete water, salts, and protein wastes.*

**Storage of the foods within the body.** When more carbohydrate is eaten than is needed for immediate use in the body, it is changed to a starch-like substance called *glycogen*, and is stored within the cells of the liver and to a certain extent in the fibers of the muscles. When the supply of sugar in the blood runs low, this reserve store of glycogen is broken up again into sugar and given off into the blood to feed the cells.

When more fat is eaten than can be used in the body, certain cells take it in and store it within themselves until they become little more than bags of oil. These cells, massed together, form the fat that you see in the body of an animal. When a person is sick and does not eat, the body uses this fat for food.

FIG. 121. Fat cells. They are little more than bags of oil.

A small amount of protein is dissolved in the blood, but the great storehouse of the protein in the body is the muscles. The muscles are built up when we eat a diet that is rich in protein, and when for any reason we are deprived of food, the muscle fibers are broken down and used to nourish the cells of the heart, the brain, and other vital organs. Famine sufferers and persons who

have come through long sicknesses are little more than skeletons because their muscles have been used to sustain the organs necessary for life and the fat has been used to give the body heat and strength.

**Surplus food in the body**. When we eat more carbohydrate than can be stored in the liver and muscles, it is converted into fat and stored in this form. Usually we lose our appetite for carbohydrates and fats when we have had enough to furnish a reasonable supply of fat in the body. We can, therefore, in most cases trust our appetites to tell us when we have had enough bread, potatoes, fat meat, butter, or other starchy or fatty foods (page 389). There are, however, a few persons whose cells oxidize these foods very slowly, and such persons become too heavy and fleshy if they eat freely of foods of this kind.

When more protein is eaten than can be used or stored in the body, it is broken up, and excreted through the kidneys.[1] From this protein the same wastes are formed that are formed from the breaking down of the protein of the body cells. A heavy diet of meat, or of other foods that are high in protein, therefore, gives the liver large amounts of protein wastes to change into urea, and sometimes more of these wastes are thrown into the blood than the kidneys can excrete. This subject we shall discuss in more detail in the next chapter.

**Alcohol as food.** Alcohol in small quantities can be

[1] In the breaking up of the excess protein, the carbon and hydrogen in it are converted into either sugar or fat and used to give the body heat and strength. It is not to be understood, therefore, that surplus proteins are entirely useless to the body. The point is that they yield only energy, and this can be obtained much more cheaply from carbohydrates and fats without filling the body with poisonous wastes.

used to furnish strength to the muscles. In quantities up to two ounces a day it is oxidized within the cells and gives heat to the body. Because it can be used in these ways, it is often stated that it is a food. The modern idea of a food, however, is that it must not only furnish building material or energy to the body, but that *it must also be harmless when it is broken up within the cells.* This definition of a food is, we think, a correct one; for certainly the toxin of the tetanus or the diphtheria germ is not a food, opium is not a food, and strychnin is not a food.[1] Yet all these poisons are taken into the cells and are broken up in them, and they must furnish a small amount of heat to the cells.

We cannot, therefore, say that alcohol is a food because it is used by the cells, but before making our decision on this point we must know whether in being broken up within the cells it damages them — whether it interferes with those wonderful processes that keep the protoplasm alive. When we view the question in this light, we must decide that alcohol acts as a drug rather than as a food; for, as a drunken man shows, the action of the mind is dulled and made very uncertain by alcohol; under its influence the muscles are weak-

[1] Alcohol is composed of carbon, hydrogen, and oxygen. It is made from sugar, has in it the same elements that are found in sugar, and it would seem reasonable to expect it to act as a food toward the cells. We must, however, recognize that not only what elements are in foods and drugs, but also the way they are built together, is important; for carbolic acid is built of the same materials and is closely related to sugar and alcohol, and strychnin and cocain are composed of carbon, hydrogen, oxygen, and nitrogen, — the same elements that are most abundant in protein foods. Just why substances that are composed of the same elements should affect the cells so differently is hard to explain, but it is one of the facts of chemistry that we must accept.

ened and their control is lost; and its whole effect on the body is that of a drug and not of an ordinary food. Even in small amounts, — amounts far too small to produce signs of intoxication, — there is good reason to believe that alcohol interferes with the enzymes that break up the food within the cells and throws the life processes of the protoplasm out of their natural course.[1]

**QUESTIONS**

What becomes of the materials in a candle when the candle is burned? What happens to the carbohydrates and fats within the cells of the body? What becomes of the carbon dioxid that is formed in the body? What becomes of the water? What does the body gain by the oxidation of the fuel foods?

What is constantly happening to the protoplasm of the body? What happens to the protein food before it is oxidized? What

[1] In the Hygienic Laboratory of the United States Government at Washington, an experiment was performed with mice and guinea pigs that gives reason for believing that alcohol does not act like ordinary foods within the cells. In this experiment, the animals were given acetonitrile, a drug that is not itself a poison but which breaks up into poisonous compounds within the body. When an animal was given along with the acetonitrile the smallest quantities of alcohol, the acetonitrile was broken up much faster than is natural and the animal was poisoned by a dose too small to have any appreciable effect when alcohol was not given. *This proves that the alcohol changes the processes that go on within the cells.* It does not, of course, prove that they are changed in a way that is injurious when acetonitrile is not given with the alcohol, but there is a quite wide-spread belief that even small quantities of alcohol have an evil effect on the changes that the protein foods undergo within the cells. Until we know that this is not the case, it is unreasonable to include alcohol in our list of foods. It should be understood that the above results followed the administration of alcohol in amounts "far too small ever to cause indications of intoxication and in doses which almost certainly cause no anatomical lesions which could be detected by present methods."

wastes are formed from the proteins? Describe the structure of a kidney. What is the function of the kidneys?

How is carbohydrate stored in the body? Under what conditions will the glycogen be changed again to sugar? How are excess sugar and fat stored in the body? Of what use is the fat in the body? Where in the body is protein stored? What happens to the muscles and fat of famine sufferers?

What happens if more protein is eaten than can be used or stored in the body? In what way is a heavy protein diet injurious to the body?

Define a food. Why is alcohol sometimes classed as a food? What reason is there for not including it among our foods?

### SUGGESTIONS TO THE TEACHER

Review the reasons why the body needs food. Have the pupils distinguish clearly between matter and energy. Emphasize the fact that except in the building foods it is the energy and not the matter that is valuable to the body, and that the useless matter has to be thrown out of the body as wastes.

The books referred to on pages 356 and 369 give full accounts of the chemical reactions within the cells and of the wastes resulting from these reactions, and Chittenden's *Nutrition of Man* (Frederick A. Stokes Company, New York) treats especially the question of the protein requirements of the body. Locke's *Food Values* (D. Appleton & Co.) gives in convenient form the chemical and energy values of average helpings of prepared foods, and Gephart and Lusk's *Analysis and Cost of Ready-to-Serve Foods* (Journal American Medical Association, Chicago, price 15 cents) is of especial value to those who eat in restaurants.

The teacher should write to the Child Health Organization, 370 Seventh Avenue, New York City, for tables showing the proper weights for boys and for girls of given ages and heights. Attention should be called to the fact that the weight of the body represents the food that has been taken in by the body but not oxidized — the excess of income over outgo — and that the weight can be increased or decreased by regulating the intake of food.

# CHAPTER EIGHTEEN

## FOODS AND HEALTH

How shall we know what foods we ought to eat and how much of each is best for us? Occasionally the idea is advanced that in selecting a diet the best plan is to follow the appetite, — that the lower animals keep in health by eating the food they like, and that when the body calls for anything it does so because it needs it. It would be fortunate for us if by following this simple rule we could always be sure of keeping our digestive organs in order and of supplying our bodies with the materials that they need. But as a matter of fact this is not the case. Young rats that were allowed to eat freely of 23 different grains and vegetable foods failed to grow to more than half normal size, while other rats, compelled to live entirely on a mixture of rolled oats and dry alfalfa leaves, reached their full size. Certainly many persons crave foods that they know will be injurious to them, and in the selection of foods, rules and principles must be followed as well as the appetite, if the diet is to be adapted to the body's needs. The amount of protein needed by the body has in the past been one of the most disputed of all the questions pertaining to diet, and we shall begin this chapter by a discussion of that question.

**Quantity of protein needed by the body.** When men are given an abundance of food and are allowed to select the kinds that they like, it is found that the average man consumes daily from four to four and one half ounces of dry protein. Some individuals eat far more and a

few persons take much less than this amount, but a little over four ounces is the quantity of protein eaten by the average prosperous American or European.

But many persons keep in health when eating much less than this amount of protein, and recent investigations have shown that proteins differ from each other and that the amount of protein needed by the body depends upon the one that is taken. In digestion the proteins are split into *amino-acids*. These are absorbed into the blood and are used as the building stones with which the body repairs its wastes and grows. Nearly twenty amino-acids are now known, which different proteins yield in different amounts; some proteins lack certain amino-acids altogether, while others they furnish only in small amounts. For its building purposes the body picks out from the blood as much of each of the different amino-acids as it needs, using the remainder for fuel as it uses sugar and fats.

FIGS. 122 and 123. A Roman and a Japanese soldier. They made their reputations as fighters on a low-protein diet.

Meat, fish, milk, and egg proteins are complete; they supply in large amounts all the amino-acids that the body needs. The proteins of grains, beans, and peas are low in certain amino-acids and must be eaten in large

amounts if they are the sole source of protein supply. Potato protein seems to be of good quality, although it is supplied in only small amounts. When a number of different kinds of foods are eaten, the amino-acids lacking in one food may be furnished by another, and thus all the needs of the body will be met. All the protein needs of the body can be met with vegetables, but including meat, milk, or eggs makes it much easier to plan a satisfactory diet. The proteins of soy beans and of peanuts are of better quality than most vegetable proteins. Gelatin is a protein of very low grade.

**The muscular endurance of low-protein subjects.** All vegetarians live on a low protein diet. That it is possible to maintain the body in health and strength on such a diet is shown by the muscular endurance of vegetarians. In one seven-day walking race of 372 miles, two vegetarians won first and second places, beating the fastest flesh eater by 22 hours. In another great walking race of 124½ miles, in which there were thirty-two competitors, the first six men who arrived were vegetarians, the seventh and eighth were meat eaters, and the ninth, tenth, eleventh, and twelfth were vegetarians. In January, 1912, the Edinburgh Marathon race (25 miles) was won by the Finnish runner, Kolehmainen, who is a vegetarian. This same man in the 1912 Olympic games at Stockholm went to the post on six successive days against the best runners of all the world, and six times he defeated them all so easily that he is declared to be "the greatest of all Olympic heroes — the best long distance runner who ever wore spiked shoes."

Many other athletic contests have been won, and are

being won, by vegetarians, but since in all cases of this kind much depends upon the individual, we shall give some average endurance tests that have been tried on a number of individuals at the same time. Professor Irving Fisher of Yale University selected fifteen athletes who were living on a high-protein diet and tested their endurance. He found that on the average they were able to hold their arms extended for ten minutes. One man, who was a baseball pitcher and had powerful shoulder muscles, was able to hold his arm extended for 22 minutes. The endurance of thirty-two young men, vegetarians and low-protein subjects, but not athletes, was then tested by the same method. These men were able to keep their arms extended on an average for 49 minutes, practically five times as long as their meat-eating competitors. One of them made a record of 200 minutes, more than nine times as long as the best high-protein athlete.

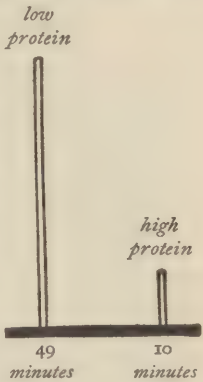


FIG. 124. The low-protein subjects held their arms extended for 49 minutes on an average; the high-protein subjects for 10 minutes.

Nine of the Yale athletes were then given the deep knee-bending test. On an average they were able to go through with this exercise 383 times. Twenty-one low-protein subjects were given the same test and their average record was 833 times. At a later time one of the low-protein subjects, a young man twenty-two years old, who had lived on a vegetable diet for two years, made the deep knee-bend 5002 times, 1555 times more than it was made by all the nine high-protein athletes.

**Objections to a heavy meat diet.** Because meat is rich in protein, much of the discussion as to the protein needs of the body has centered about the advisability of eating meat. Some persons have insisted that it is injurious to the body and that it should not be used at all as an article of food. As we have shown, it is possible to keep the body in health with a vegetable diet, provided milk is also used, but there is no proof that a moderate amount of meat is harmful to the average person. But because meats are pleasant to the taste, very large amounts of them are sometimes eaten. This is objectionable for the following reasons:

(1) *Meat does not supply the minerals and the vitamins that the body needs.* If large amounts of meat are eaten, small quantities of other foods will be taken and some of the needs of the body may not be supplied.

(2) *Large amounts of meat in the diet cause poisonous substances to be formed in the intestine.*[1] When more protein is eaten than the pepsin and trypsin can digest in a reasonable time, part of it passes undigested into the large intestine. Here bacteria cause it to decay, and in the process of decay poisonous substances are formed. These poisons are then absorbed into the body, and they cause headaches and other disturbances by poisoning the cells.

(3) *Meat does not supply the bulk that is needed in the*

[1] Individuals differ enormously in the kinds of bacteria that grow in the intestines and in the amount of poison formed by them, and these substances are often abundant in the intestines of animals that live on a vegetable diet as well as in the intestines of meat-eating animals. Nevertheless, it is true that in the average person a diet of vegetables and milk causes small quantities of the poisons to be formed, and a diet of meat and eggs causes an increased quantity of them to be formed.

*diet.* The lack of bulky material causes the wastes to lie for a long time in the intestine, and this causes more of the poisons to be absorbed from these wastes than would be absorbed if they were promptly removed from the body.

(4) *A heavy meat diet loads the system with protein wastes.* This is probably injurious, in some cases at least. It has long been believed by many physicians that an excess of substances of the uric acid class is the cause of gout and other serious ailments. Part of the trouble, at least, seems to lie somewhere in the protein wastes, and the patients are benefited by cutting the protein to a low point.

Because of these facts it is wise to eat only moderately of meats and to use other articles of food more liberally than they are used when meat is taken in large amounts.

**The energy needs of the body.** *The body must have enough food to provide it with heat and with strength for the work that it does.* A certain amount of food is burned in the body, even when the body is completely at rest. After eating, the amount of food burned by the cells is greater. When work is done by the muscles, the amount of food used is increased, — enormously increased if hard work is done.[1] Exposure to cold causes the muscles to have a greater tension, and thus increases the amount of food burned in the body and the amount

[1] The energy content of food is measured by the heat it yields when burned. The unit of measurement is the Calorie, which is the amount of heat required to raise a liter of water one degree Centigrade. Roughly, it is the amount of heat required to raise one quart of water two degrees Fahrenheit. The body gets the equivalent of about 4 Calories of heat for each gram of dry carbohydrate or protein eaten, and about 9 Calories from

of heat released. Cold also causes a person to move about more, and to swing the arms and stamp the feet, which increases the heat production of the body; it may cause shivering, which brings still other muscles into use. In young persons the food is burned very rapidly in the cells, a boy or girl of ten or twelve years requiring as much food as a man or woman, and young persons of 16 and 17 years much more than middle-aged persons. Women require somewhat less food than men, and in old persons the food is not used so rapidly by the cells.

**Effects of a diet that does not yield enough energy.** A group of young men placed on a diet that yielded insufficient energy continued to grow thinner until they had lost a little more than 10 per cent of their weight. After that their bodies burned less food, and they continued to live on this low level without further loss of weight. They did not become ill, but they lacked vigor, and when they attempted severe muscular exercise they found that they lacked strength for it.

During the recent war many millions of persons were

each gram of fat. An average-sized man needs enough food to yield the following numbers of Calories:

| | |
|---|---|
| Absolute rest in bed without food | 1680 Calories |
| Absolute rest in bed with food | 1840 Calories |
| Office work or other light work, about | 2500 Calories |
| Light muscular work | 2700 Calories |
| Moderately active muscular work, as work of farmer or mechanic | 3400 Calories |
| Hard muscular work | 4000 Calories |
| Very hard muscular work | 6000 Calories |

In a boys' school where most of the pupils were from 13½ to 16 years of age, the food used had a value of almost 5000 Calories for each pupil.

forced to live on this low plane, and at all times great numbers of persons in all countries are undernourished. This is especially true of children; among both the rich and the poor great numbers of boys and girls are underfed. Sometimes this is because not enough food is provided. More often it is because the child is not hungry and eats only certain of the articles of food that are placed on the table.[1] Such children are in a low state of vigor, they do not grow fast enough, and it is believed that they have less resistance to infections than they would have if they were well nourished. The best indication as to whether enough food is being provided is the weight.

**Food for energy.** Bread, grains, potatoes, butter, sugar, and fat meats are the foods on which we mainly depend for our energy. The body can use for fuel purposes any protein that is not needed for building material; but proteins are expensive foods, and, as we have seen above, it is not wise to eat too heavily of them. The thing to do, therefore, is to eat the proteins that we need for building material and then take enough fats, starches, and sugars to give us plenty of heat and strength. Usually we can trust our appetites to tell us when we have had enough of these foods. Taking food into the body increases the amount that is burned in the cells, and the amount of body heat produced. Carbohydrates increase the heat production least, fats increase it more,

[1] The sensation of hunger is due to the contraction of the muscles of the stomach, and these muscles do not necessarily contract when the body needs food. It is generally supposed that children overeat, but far more of them do not eat enough. The trouble comes from the fact that they eat too much of sweets or other foods that gratify the appetite and refuse many articles of ordinary food.

and proteins increase it most of all. A winter diet, therefore, should be higher in fats and protein than a summer diet. Meat helps to keep up the body heat in winter, and a diet consisting largely of fruits and vegetables is advisable on hot summer days.

**The mineral supply of the body.** This subject has already been discussed (pages 351–354). In general, eating large amounts of meat and sugar causes a lack of minerals, and a diet of vegetables and milk supplies minerals. Of all the minerals, the one most commonly lacking is calcium, which can be supplied by the free use of leaf vegetables and milk.

**The vitamin supply.** Whole grains, peas, beans, and vegetables contain abundant supplies of the vitamin that prevents beriberi. Milk is moderately rich in this substance. Practically all of our population have enough of this material. The other vitamin is found in the leaves of plants, in the yolk of eggs, and in milk and butter. An animal like the cow or rabbit can eat enough grass or leaves to supply it with this vitamin, but a human being cannot do this. Milk and butter should therefore be used. The livers and kidneys of animals supply this second vitamin (it is found in cod-liver oil), and it is reported to be present in the fat of fish.

**General dietary principles.** The seeds of plants are our chief source of food; wheat and corn bread, breakfast foods, oatmeal, rice, macaroni, peas, beans, and nuts make up the greater part of the diet of the people in temperate climates. Fruits and vegetables like potatoes, turnips, and carrots furnish about the same elements to the body as grains. A diet composed of these foods is likely to lack certain of the needed amino-acids,

calcium, and the vitamin found in leaf vegetables, eggs, and milk. Meat will make good the lack in the protein, but it will not supply the calcium or the vitamin, and to make the diet complete eggs or milk, or leaf vegetables, must be used. As we have already seen, it is difficult for man to eat enough green vegetables to supply the lacking substances, and for this reason eggs and milk, especially milk, should be used. Grains, vegetables like the potato, fruits, and meat do not make a complete diet. Leaf vegetables, milk, or eggs also are necessary.

**The importance of milk in the diet.** All who understand the food needs of the body are agreed that it is a great misfortune that many families are using less milk than formerly because of an increase in its price. Milk is still one of the cheapest of our foods; a quart of it contains almost as much energy as a pound of steak, and it contains minerals and vitamins that can be supplied in an ordinary diet by nothing else. A certain organization that has long been at work to improve the diets of poor persons says that a quart of milk should be provided each day for a child and a pint for an adult. A noted authority on foods has stated that good milk is worth whatever it costs to produce it, and that no meat should be bought until each member of the family has been provided with a pint of milk. Another authority on foods reports that in his own family from 25 to 30 per cent of all the money expended for food is used in the purchase of milk. The most serious mistake made by our people in the purchase of food is in not buying enough milk. In the southern part of the United States it is especially important that the people in small villages and in the country provide a supply for themselves.

**Large quantities of sugar injurious to the digestive organs.** In his wild state man secured most of his sugar by eating starchy foods and digesting them to malt sugar. Now he prepares great quantities of sugar and uses it in his food, but the sugar that comes from cane and beets is cane sugar and not malt sugar. This sugar, when taken in large quantities, is very irritating to the stomach, and because in large amounts it is not a natural food for man we have but a small quantity of the enzyme that digests it. When a large amount of sugar is eaten, therefore, it may remain for a long time undigested in the small intestine, and when this occurs the sugar is likely to be fermented by bacteria and injurious acids formed from it. Sugar should be taken in moderate quantities, and it should be mixed with other foods and not eaten at a time when it will form a thick, sirupy solution in an otherwise empty stomach. A moderate quantity of candy eaten at the close of a meal has a very different effect on the digestive system from that of a large quantity taken before a meal.

**Fats.** Fats hinder stomach digestion, and except in very cold weather few persons can take a daily ration of more than three and a half ounces of fat without bad results. Persons who suffer from acid stomach are advised to eat liberally of fatty foods, and about two ounces of fat should be included in the average daily diet. Certain individuals who refuse to eat butter, fat meat, olive oil, or other fatty foods, live on very small quantities of fat, and get their energy almost entirely from carbohydrates. This leaves the lipase without any work to do and throws a heavy task on the starch-digesting enzymes, and it is not so likely to give a well-ordered

digestion as a mixed diet. It is also believed that the cells of the body keep in better health when part of their nourishment is supplied in the form of fat; that persons who eat little fat are more subject to germ diseases, especially tuberculosis, than are those who eat reasonable quantities of fatty foods.[1] During the war more hardship seems to have been caused by a lack of fats than by a shortage of any other class of foods.

**Eating vegetables beneficial to the health.** Coarse vegetable foods like string beans, cabbage, cauliflower, carrots, turnips, potatoes, beets, radishes, asparagus, lettuce, celery, and spinach are very necessary to the health. They furnish minerals to the body and after they are digested there remains much bulky refuse matter that causes the wastes to be moved rapidly along the intestine. These are the foods that are least palatable to most persons, and they are the ones that are most frequently left out of the diet. One difficulty in getting enough of these vegetables into the diet is that in the country the family garden is often neglected and a sufficient variety of them is not produced. Another difficulty is that in towns and cities these vegetables are often needlessly allowed to wilt in stores and markets, and their tenderness is lost before they are cooked. The chief difficulty, however, is that only a few persons un-

[1] Fat is considered the most important part of the diet in tuberculosis. Outdoor life in this disease is more beneficial in cold climates than in warm climates and more beneficial in winter than in summer. Some physicians think that this is because in winter the exposure to the cold increases the appetite for fat. Milk and eggs have always been used as a source of much of the fat in the treatment of tuberculosis, and it is possible that a part of the benefits that are supposed to come from the fats in the diet is due to an abundant supply of the vitamin that is found in these foods.

derstand how to cook vegetables so that they will come to the table with the attractive flavors and odors that an expert vegetable cook can bring out. Because it is a difficult art to do this, many housewives give their attention to the easier and simpler tasks of cooking meats and of making pies, cakes, and desserts, and serve on their tables vegetables cooked in an unappetizing way. It is very important that the proper attention be given to the raising and preparation of these foods, and every young person should learn to eat all the different kinds of vegetables that are served in his home.

**A plan for getting a proper diet.** Since the very life of the body centers around the food from which the cells build their living substances and from which they get their energy, it is easy to understand that the question of diet is the most important problem of all hygiene. It is not possible to give any simple rules that will always be a complete guide in eating, but the following suggestions may be helpful:

(1) *Eat enough food.* Only the energy needs of the body are increased by work, and laborers who eat large quantities of food are not nearly so likely to suffer from a lack of protein, minerals, and vitamins as those who take little exercise and eat only small amounts of food. Enough should be eaten to keep up the weight and vigor of the body.

(2) *Eat many different kinds of foods.* As far as it is possible to do so, make it a rule to eat at each meal one food rich in protein, like lean meat, eggs, beans, or cheese; one or more starchy foods like breakfast foods, bread, macaroni, or potatoes; some fatty food like butter, fat meat, or nuts; some coarse vegetable food like cab-

bage, asparagus, turnips, or beets; a moderate amount of some sweet food like sugar, sirup, preserves, jelly, honey, cake, or a sweet dessert. Follow this plan, and you will probably not be tempted to eat too heavily of any one

FIGS. 125, 126, and 127. Healthful sports and games do much to prevent constipation.

kind of food and will supply your body with all the different materials that it needs.

(3) *Include milk and butter in the diet.* If this third rule is followed in connection with the two rules previously given, the food needs of the body will be met.

It is very important to follow some plan that will cause enough food to be eaten and all the different materials that are needed to be supplied; for experience has proved that persons who simply follow their appetites or eat the foods that can be most conveniently secured frequently fail to supply their bodies with some of the materials that they need.

**Constipation a deadly enemy to health.** No matter what diet is eaten, unless the wastes are rapidly moved along the intestine and promptly cleared out of the body, ill-smelling gases and poisons will be formed in the refuse matter in the large intestine. These will be absorbed into the blood and cause bad breath, headaches,

and other evil consequences. In selecting a diet, enough coarse food should be chosen to give large amounts of bulky refuse matter. This will assist in causing the wastes to be moved rapidly along the intestine.

Other important points in the prevention and cure of constipation are vigorous exercise, especially bendings of the body and movements of the legs that will press the digestive organs about and help the circulation of the blood through them; massage of the abdomen, which also helps the circulation of the blood through the stomach, liver, and intestines; a daily cool or cold bath; attending to emptying the bowels regularly at a certain hour each day [1]; eating foods like fruits, corn meal, and graham flour, which have a natural laxative effect; drinking large quantities of water, especially at bedtime; and keeping the nervous system in good condition so that the digestive organs will be properly regulated. A few physicians now understand how to treat successfully patients suffering from constipation, and any one who suffers ill health month after month because of poisons produced in his own body should, if possible, put himself in charge of a physician who is especially qualified to treat this trouble.

**The cost of food.** The object of eating is to supply the body with building material, heat, and strength. To

[1] An X-ray examination of animals shows that before the bowels are emptied the part of the large intestine which runs across the body is raised up partially on end and the part which runs up the right side of the body is dragged across to take the place of the transverse portion. It takes about 20 minutes for these changes in the position of the large intestine to be brought about. It is possible to train the nerves that control the intestine until they will set the muscles of the intestine in action at regular times, and it is exceedingly important to do this.

make sure that all the needs of the body are supplied, we must eat foods of different kinds; we cannot live on corn meal and beans, no matter how cheap they may be. It is often possible, however, to supply the needs of the body either with high-priced foods or with other foods that may be purchased at a much lower rate. For example, the same amount of energy that can be purchased in wheat flour for four cents costs ninety-five cents in oysters, and protein costs nine times as much in canned corn as in corn meal.

The average family is not wealthy, and according to the best statistics available it is slightly undernourished. We cannot go into the question of food costs further than to point out that in our country millions of dollars might be saved each year and the health of millions of people greatly improved, if the persons purchasing the food supplies of families understood how to secure the most nourishment for the money that they have to expend. The average American family spends about one third of the money used for the purchase of foods for meats, fish, and poultry and less than one tenth of it for milk. Undoubtedly the diet would be improved by spending more for milk and less for meat.

## QUESTIONS

How much protein is eaten daily by the average prosperous American or European? Into what are the proteins split in digestion? For what special purpose are amino-acids used by the cells? How do proteins differ as to the amino-acids they supply? Name some foods that furnish protein of high grade; some foods that furnish less valuable protein. Give some arguments for a low-protein diet based on the

muscular endurance of vegetarians and other low-protein subjects. Give four objections to a heavy meat diet.

How much food does the body need? At what time of life is most food required? What is the result of living on a diet that does not supply enough energy? What shows whether enough food is being provided? Is your weight what it ought to be?

What foods furnish an abundance of minerals to the body? What foods are rich in each of the vitamins?

Name some of the chief energy-yielding foods. What class of foods most increases the heat production of the body? What foods can be used to increase the heat production of the body in winter? What foods will keep the amount of body heat produced lowest in hot weather?

What other classes of foods supply the same materials as seeds? What needed substances are lacking in these foods? Explain how each of these substances may be supplied. Why is it important that milk be used freely?

Why is sugar injurious to the stomach and intestines when eaten in large quantities? When is the proper time to eat candy? How much fat should be included in the daily ration? Why is it unwise to depend entirely upon carbohydrate foods for energy and to exclude fatty foods from the diet?

Why are coarse vegetable foods necessary for the health? Give some of the reasons why these foods are often omitted from the diet.

Give three rules for eating that will help in giving the body a proper food supply. Why is it important that some plan be followed in supplying the body with food?

Why is it necessary for the wastes to be promptly removed from the intestines? How do coarse, bulky foods assist in this? Give some important points in the prevention and cure of constipation. How does a knowledge of foods help in securing a satisfactory diet at a moderate cost?

# CHAPTER NINETEEN

## THE TEETH

THE teeth are composed of the hardest tissues in the body, but decay of the teeth is the most common bacterial disease of man. Unlike many other infections, this disease runs on and on, and can be checked only by a surgical operation that removes the infected tissues and the germs that are in them. We have therefore a whole class of surgeons (dental surgeons) who give their entire time to the treatment and prevention of infections of the teeth and their surrounding parts. In recent years it has been proved that defective teeth are more injurious to the health than had been suspected, and the importance of keeping the teeth sound can hardly be exaggerated.

**How bad teeth injure the health.** Bad teeth cause the food to be swallowed in large pieces and thus greatly delay digestion. They also allow germs to gain entrance to the bones of the jaw and establish centers of infection in these parts. These germs are usually slow-growing races of streptococci that live in the bones for years, and often the health is greatly injured by the toxins that are absorbed from them. Frequently the germs are carried from the teeth to other parts of the body and by growing in these parts cause rheumatism, heart disease, kidney disease, and other ailments. This subject will be discussed in a later chapter (pages 446–454).

**The structure of a tooth.** A tooth is composed of a *crown*, a *neck*, and one or more *roots*. The main bulk of the tooth is composed of *dentine*, or ivory, a substance harder than the most compact bone. The crown is covered by a coat of *enamel*. This substance is very hard,

but brittle like glass. The enamel can easily be broken by biting on hard objects, and it may be cracked by very hot food or drink taken into the mouth. If it is once broken off it is never replaced, and without the covering of enamel over it the dentine soon decays. The roots of the teeth stand in sockets in the jaw-bones and are covered by a layer of bone-like cement. Lining the socket in which the root stands is a layer of connective tissue that fastens together the root and the bone of the jaw. In the center of the tooth is the *pulp cavity*, a little chamber containing nerves and blood vessels. Break open the tooth of an animal, and you will easily find the enamel, the dentine, the pulp cavity, and the little root canals through which the nerves and blood vessels enter from the jaw-bone.

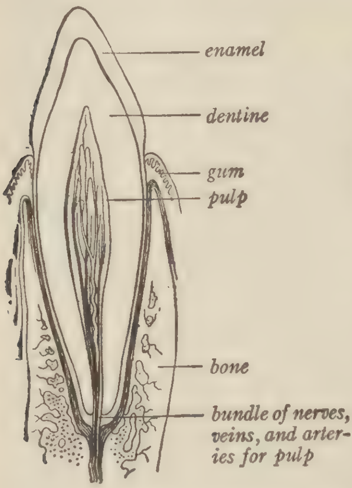



FIG. 128. A section through a tooth showing its structure and how it is fastened into the jaw-bone.

**Why a tooth decays.** Decay of the teeth is caused by bacteria that grow in the materials that stick to the teeth and lodge between them. It is thought that the bacteria start the decay by forming acids that eat away the enamel. Then other kinds of bacteria enter the cavity and destroy the dentine. If the decay is allowed to go on until the pulp is reached, this is killed and the

germs not only grow in the dead pulp but enter the jaw-bone through the root canal and set up their growth about the end of the root. When the decay is reaching the pulp, but when the nerve endings in the pulp are not yet dead, the tooth may ache. A gum boil is due to infection at the root of a tooth.

**The teeth preserved by keeping them clean.** The way to preserve the teeth is to keep them clean, so that bacteria cannot find a home around them. The teeth should be brushed both inside and outside after each meal, and food that is lodged between them should be carefully removed. This point is important because decay nearly always begins between the teeth. Some dentists recommend that the food be removed with dental floss, but in the hands of the average person a toothpick is more effective. A quill pick is less likely to injure the gums than a wooden or metal one. Rinsing water about vigorously in the mouth and driving it between the teeth removes many small food particles, and this should always be done after the teeth have been brushed.

A good tooth powder or paste is an aid in cleaning the teeth. Prepared powders or pastes may be used, or a good powder made of precipitated chalk and powdered orris root, which may be purchased from any druggist. Charcoal, pumice stone, or other gritty substances should not be used, as they scratch the teeth and leave

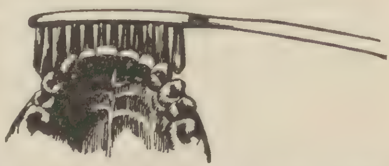


FIG. 129. A curved brush with the bristles longer at the ends cleans the teeth better than a straight brush.

little grooves in the surface where food and bacteria collect. A curved brush with the bristles longer at the

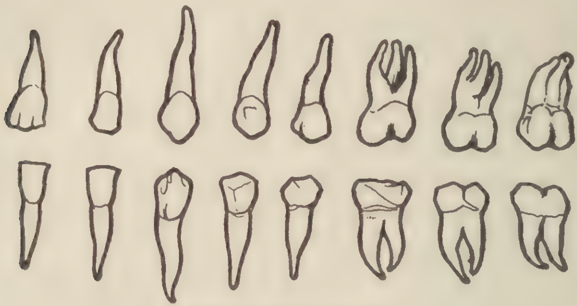


FIG. 130. One half of the permanent set of teeth.

ends cleans the teeth better than a straight brush; a medium-sized brush with moderately stiff bristles should be used.

**Deposits on the teeth.** The mucus of the saliva forms a film over the teeth, and in many mouths patches of gummy material collect on the teeth where they are not cleaned in chewing the food and by brushing. These deposits are called *dental plaques*, and they are filled with living bacteria that produce acid and start decay beneath the plaques. *Tartar* is a hard mineral deposit that usually forms most abundantly along the edge of the gums. It is often stained brown by the escape of blood into it and may become bluish, green, or almost black from changes in the coloring matter of the blood in it.

Thorough brushing of the teeth helps to keep them free from dental plaques and tartar, but these may appear on places where the brush cannot reach them or

even, in spite of the most careful cleansing, where the brush does reach. It is important, therefore, to visit a dentist from time to time to have any deposits on the teeth removed.

**The care of the gums**. In many persons the gums are slightly inflamed along the margins and bleed easily when they are brushed. To keep them in health it is very important that tartar on the teeth be removed, for the tartar irritates the gums and causes them to shrink, leaving the roots of the teeth bare. This inflammation and receding of the gums may allow germs to work down about the roots of the teeth and form pus about them, thus causing them to become loose in their sockets. When the teeth are cleaned, the gums should also be thoroughly brushed with a light, quick stroke that will stimulate the circulation in them but will not injure them. One dental authority states that inflamed gums can be surely restored to health if the gums and teeth are brushed in the proper manner for two minutes four times a day. Some writers advise that in cleaning the back teeth the brush be given a twisting movement, and that the brushing be always from the gums toward the crowns of the teeth. Others believe that the outer surfaces of the back teeth can be best cleansed by giving the brush a circular or rotatory motion. All authorities are agreed that the brushing should not be crosswise on the teeth. The purpose of brushing is to prevent cavities from forming in the teeth and to keep the gums in health, and the brushing should be frequent enough and thorough enough to accomplish this purpose. It is best to have two tooth brushes, as a brush becomes soft when too frequently used.

**The importance of visiting the dentist frequently.** It is very important that the teeth be inspected by a dentist at regular intervals and be given any treatment they may need. If the dental plaques are not removed, decay may start beneath them. Tartar that is not removed irritates the gums and causes them to become inflamed and to shrink. A most necessary part of the care of the teeth, therefore, is to have any deposits on them removed promptly, and a dentist should examine the teeth every three months to see if this needs to be done.

It is also important that cavities be filled while they are yet small, both because this plan preserves the teeth and because it is more economical and less painful than waiting until the cavities have enlarged and a great part of the tooth has been eaten away. All over the land people are suffering with toothaches and paying for expensive X-ray work, root fillings, and crown and bridge work when they could have preserved their teeth by spending a mere fraction of the same money at an earlier date for small fillings. If the pulp of the tooth dies and the germs gain entrance into the bones of the jaw, it is exceedingly difficult to eradicate them and sometimes it is impossible to do so. It is not considered safe to fill a dead tooth unless the X-ray is used to make sure that the filling extends to the end of the root canals; even after the roots are filled it is considered advisable to put a temporary filling in the tooth, and after a time to examine it again with the X-ray to make sure that no infection has developed in the bone at the tips of the roots. Dental work of this kind is very expensive, and it is much more satisfactory to have the teeth attended to when only

cleaning and small fillings are required. Unless decayed teeth can be so treated that they will be free from germs, it is better to have them extracted, and there are not a few dentists who believe that a dead tooth is better out of the mouth than in it.

**The temporary teeth**. The jaws are too small in childhood to hold the large teeth that we need in later life. In early life we have, therefore, a set of twenty small *temporary teeth*. This set is composed of four *incisors*, two *canines*, and four *molars* in each jaw (Fig. 132). The incisors are flat and chisel-like for biting off the food. The canines are more round and pointed, and in the dog and other carnivorous animals they are used as weapons and for tearing flesh. The molars are broad, square teeth with square *cusps*, or points, and wide surfaces for crushing and grinding the food. About the sixth year the temporary teeth begin to drop out, and by the twelfth or fourteenth year they have all been replaced by permanent teeth.

**The permanent teeth**. There are thirty-two permanent teeth. In each jaw there are four incisors and two canines that replace the incisors and canines of the temporary teeth; four *bicuspids* in place of the temporary molars; and six molars that come in behind the space occupied by the temporary teeth. The first permanent molars appear about the sixth year. The third

FIG. 131. The tooth on the right decayed, the roots were not absorbed, and the tooth had to be pulled to make room for the permanent tooth. The tooth in the middle shows the roots partly absorbed. The roots of the tooth on the left have been completely absorbed and the tooth has dropped out.

molars, or wisdom teeth, usually appear from the sixteenth to the twenty-first year, but in some persons these teeth never make their way through the gums.[1]

**The importance of caring for the temporary teeth**. The first reason for caring for the temporary teeth is that they themselves are necessary for the health; for if they are allowed to decay, the child will form the habit of bolting his food; the digestion will be deranged by the germs that are swallowed; and the nervous system and the disposition will be damaged by the pain from the toothache that the child will be compelled to endure. For the sake of the health during the years of childhood and to prevent the forming of wrong eating habits, the temporary teeth should have the best of care.

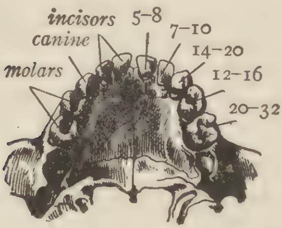



FIG. 132. The upper temporary teeth of a child about three years old with the average time of eruption given in months. The lower teeth usually appear a few weeks earlier than the upper. The first permanent molars, which at this time are being formed in the jaws, are shown behind the temporary teeth.

The second reason for caring for the temporary teeth is to prevent the permanent teeth from coming in irregularly. The permanent teeth begin to form long before

[1] Sometimes when the wisdom teeth or other teeth fail to appear at the normal time it is because they have turned sideways in the jaw or have become tightly wedged among the roots of the other teeth. Teeth that are lodged in the jaw in this way are called *impacted* teeth, and there are many cases on record of persons who suffered greatly from nervous troubles because of the pressure such teeth were exerting. If the teeth do not appear at the proper time and there is any trouble with the health, impacted teeth should be looked for. The X-ray is used in making the examination.

birth at the roots of the temporary teeth, and by the end of the third year even the wisdom teeth are formed in the jaws. These teeth then gradually grow and harden, and the roots of the temporary teeth disappear before them (Fig. 131). Finally, the roots of the temporary teeth are entirely absorbed and the first teeth drop out, leaving the places they occupied to the permanent teeth.

If the temporary teeth are allowed to decay, their roots are not absorbed before the permanent teeth. The second teeth, therefore, either remain buried in the jaws or appear in an irregular line, some inside and some outside of the line of the first teeth. Another difficulty caused by decay and loss of the temporary molars is that when the first permanent molars come in they move forward and take positions that belong to the bicuspids and there is then not enough room for the permanent bicuspids. For the sake of the permanent teeth, therefore, the temporary set should have the best dental care, and if for any reason they have been allowed to decay, a dentist should be consulted when it is time for the second teeth to appear. Permanent fillings and not cement fillings should be used in the temporary teeth, for some of these teeth remain in the mouth until the child is 10 or 12 years of age.

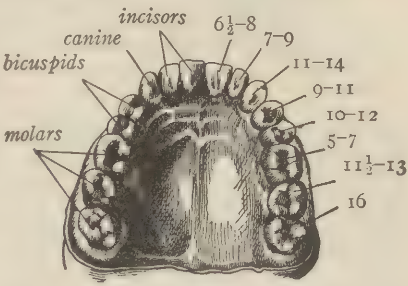



FIG. 133. The upper permanent teeth of a man twenty-six years old, with the average time of eruption given in years. The lower teeth usually appear two or three months earlier than the corresponding upper ones.

**The importance of caring for the first permanent molars.** The first permanent teeth, which come in about the sixth year, behind the temporary molars, are often mistaken for temporary teeth. These molars have deep grooves in their surfaces in which the food lodges, and they come into the mouths of many children before the habit of washing the teeth has been formed. They are therefore especially liable to decay. They should be filled at once if cavities appear in them, because they are not replaced when lost, and without them the jaws do not grow in length as they should. Count the double teeth in the mouth of a six- or seven-year-old child, and if there are three of them on one side of the jaw, the back one is a permanent molar.

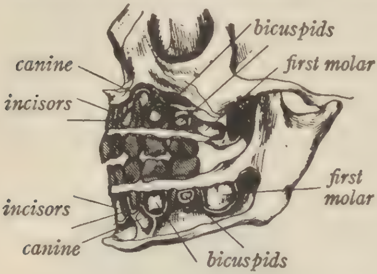



FIG. 134. The jaws of a child four years old. The jaw-bones have been cut away to show the permanent teeth growing at the roots of the temporary set.

**Other points in the care of the teeth**. Sticky foods like oatmeal and mashed potatoes cling to the teeth and cause them to decay. Hard foods like apples, cornbread, and bacon clean the teeth and give the gums the exercise that is needed to keep up the circulation through them. Every diet, therefore, should contain some tough, solid material into which the eater can set his teeth. Sugar left among the teeth ferments easily and causes decay. For this reason eating candy at all hours of the day, so that the crevices among the teeth are kept filled with it, is almost sure to cause decay.

**Straightening irregular teeth.** Often the permanent teeth come in irregularly and are turned forward in front because the temporary teeth have been allowed to decay or because adenoids or nasal growths have kept the bones of the jaws and of the roof of the mouth from growing enough to make room for the teeth. When for these or any other reasons the teeth are irregular, a dentist who understands how to straighten them should at once be consulted. By putting pressure on the teeth the bones may be made to grow larger and the arch of the jaw expanded until the teeth have sufficient room.

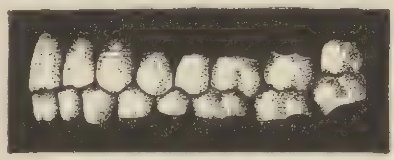


FIG. 135. This shows how the upper teeth should close on the lower teeth. (*After a photograph from "The Practical Orthodontist."*)

Figure 136 gives an idea of the changes that a good dentist can make in the appearance of a person whose mouth is spoiled by irregular or protruding teeth. The work of straightening the permanent teeth ought to be begun as soon as they appear, and not delayed until all of them are in the mouth, as is often advised. A tooth that has been crowded out of line ought not to be pulled, but the circle of the teeth should be widened until there is room for all.

**Defective teeth due to illness and to lack of calcium in the diet.** A tooth is first built up by the growth of a "bud," or little group of cells of the mucous membrane which covers the jaw. It is then hardened by having calcium deposited in it. This hardening of the teeth is going on all through childhood, and severe cases

of scarlet fever, measles, diphtheria, and other illnesses may interfere with the deposition of lime and cause the teeth to be soft and ill-formed when they come through the gums months or years later.

Defective teeth may also be caused by lack of calcium in the diet, as we have already pointed out (page 352). It is therefore especially important to the teeth

FIG. 136. Two cases in which the teeth needed and received the care of a good dentist. (*After a photograph from "The Practical Orthodontist."*)

that children be guarded from disease and that an abundance of lime be supplied in the food during the early years of life. The question of lime in the diet should be given special care when babies are brought up on any food other than milk.

**Care of the mouth of an infant.** Little babies often suffer from sore mouth. This disease is caused by germs and is usually brought on by lack of cleanliness. It should be promptly attended to by a physician, because it not only causes suffering and nervousness in the child but also fills the alimentary canal with germs

and ruins the digestion. When the teeth are making their way through the gums, the mouth should be examined to see that there are no little ulcers on the gums when the teeth are cutting through. If these are found a physician or a dentist should be consulted; for it is very unwise to allow a child to go on swallowing the many thousands of pus-forming germs that come from the ulcers. One of the best means of preventing trouble in the mouth of a baby is to wipe out the mouth, after feeding, with a clean cloth that has been dipped in a saturated solution of borax or boric acid.

**Decayed teeth very common**. Among the 846 children examined in a school in Cleveland, Ohio, only three had perfect teeth. Examinations of many thousands of other children show that often as many as 95 per cent of them are in need of dental care. The great majority of young persons lose their first permanent molars before they are twenty years of age, and it is undoubtedly true that no other part of the body is so often defective as the teeth. You should be on guard, therefore, to preserve the precious heritage which nature has given you in the form of your teeth; for your chances of health in later years depend very largely on the care that you give your teeth now. Keep them clean by all means, and if there are small cavities in them, have them filled at once.

### QUESTIONS

In what two ways do bad teeth injure the health? Name the parts of a tooth. Of what is the body of a tooth composed? With what is the crown covered? How may the enamel be injured? What results usually follow breaking

the enamel? How are the teeth fastened in the sockets? Where is the pulp cavity? What does it contain?

What causes decay of the teeth? What happens if the decay continues until the pulp is reached? How may decay be prevented? Why should particles of food that lodge between the teeth be removed? How may a good tooth powder be made? Why should gritty substances not be used to clean the teeth? What kind of brush is best for cleaning the teeth?

What are dental plaques? What is tartar? Give two important points in keeping the gums in health. How should the brush be used in cleaning the teeth? How often should the teeth be brushed?

Why is it important to visit the dentist regularly? Why should dental plaques be removed? Why should tartar be removed? Explain why it is important to have all cavities filled while they are small.

How many teeth are there in the temporary set? Name and describe the different kinds. How many teeth are there in the permanent set? When does the first permanent molar appear? Give two reasons for caring for the temporary teeth. Why are the first permanent molars especially liable to decay? Why is their loss harmful?

Why are hard foods better for the teeth than sticky foods? Why is constant candy eating injurious? How do adenoids and nasal growths affect the teeth? What should be done when the teeth are crooked? How may illness during childhood injure the teeth? What element needed for building the teeth is sometimes lacking in the diet of children?

When babies have sore mouth, what is usually the cause? What trouble should be guarded against while the teeth are coming through the gums? How can trouble in a baby's mouth be prevented?

Cite some facts to show how common defective teeth are.

# CHAPTER TWENTY

## TOBACCO

FIG. 137. The peace pipe.

WHEN Columbus returned from the West Indies, he reported that the natives carried with them to kindle fires a brand made by rolling in corn husks the leaves of a certain herb which they cultivated. He also reported that they perfumed themselves with the leaves of this herb, and that no treaty of peace could be ratified among the Indians without smoking the herb in a pipe, because they believed that when the smoke of its burning ascended to heaven the Great Spirit smelled a sweet savor and was pleased.

The use of this Indian herb became popular in England through the influence of Sir Walter Raleigh, and the custom of using it spread rapidly through Europe in the seventeenth century. At first it was thought to have medicinal value, but in a short time men of intelligence and high position came to think of it as a dangerous drug and became alarmed as to the consequences that

would follow its widespread use.[1] A great movement against the new custom then sprang up over all the known world. In Turkey the pipes of smokers were thrust through their noses; in Russia the noses of smokers were cut off, and those who repeated the offense were put to death; the church threatened the users of the weed with excommunication; and King James of England issued a protest against its use, in which he declared it to be "a custom loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in the black, stinking fume thereof nearest resembling the horrible Stygian smoke of the pit that is bottomless."

**Why the habit of using tobacco is so widespread.** In spite of all the opposition that has been offered to it, tobacco is now used over practically the whole world. In the United States the people spend for it more than four hundred millions of dollars yearly. Of course, if people spend their money in this way, it means that they will be compelled to go without food, clothing, furniture, books, music, and other things that for their health, comfort, and richness of life they ought to have; it means millions of extra years of labor for a people who are already overworked. In India all ages and both sexes are constant smokers, and in China girls of eight or nine years wear as a part of their dress a silk

[1] During the seventeenth century the plague, or "Black Death," ravaged Europe, and it was generally believed that smoking was a safeguard against this disease. It is possible that there was some foundation for this belief; for the plague is spread by fleas that come from plague-infected rats, and it may be that fleas dislike the odor of tobacco that is present on the clothes and skin of tobacco users.

pocket to hold tobacco and a pipe. Yet in India and in China the great mass of the people toil for a miserable wage that will hardly keep them alive, and in years of crop failure hundreds of thousands of them actually perish for lack of food.

Why do men put this extra burden on themselves? Why did the Indians that Columbus saw perfume themselves with the odor of tobacco? Why do men now engage in the seemingly foolish custom of drawing smoke into the mouth and puffing it out again? Let us search out the answer to this problem.

**Nicotin.** There are certain drugs that produce such pleasurable effects on the mind that people form the habit of taking them to experience these effects. Among these drugs may be mentioned hasheesh, which comes from Indian hemp and is used by the people of India. It produces a kind of intoxication and fills the mind with the most brilliant ideas of grandeur and power, causing the most pitiful specimen of humanity to feel himself a very king among men. Alcohol has something of this same effect, for it deadens the judgment and the critical powers of the mind and causes a person to regard his own efforts as brilliant, even when there is no ground for a high opinion of what he has done. Opium deadens the sensibilities to pain and produces sensations of delicious ease and luxury. Cocain, chloral, and a few other drugs produce effects that are pleasant to the mind, and men fall into the habit of taking them. The most widely used of all these drugs, however, is nicotin, which is present in tobacco. The sensations produced by it will be discussed in a later paragraph.

**Nicotin a narcotic.** Physicians speak of certain drugs

as *stimulants* and of certain others as *narcotics.* Stimulants quicken the action of the protoplasm of the cells; they make the muscles contract more strongly and cause the nervous system to conduct impulses better and to control the body with a firmer hand. Narcotics deaden the nervous system and weaken its action; they slacken the muscles and lessen their strength. Strychnin is a good example of a stimulant. It is given by physicians when the heart action flags and when there is general weakness and collapse. Opium is an example of a narcotic. It is given by physicians to dull the senses to pain and to quiet those whose nervous systems have been overwrought. The nicotin that is in tobacco is a narcotic, and it is so strong that a few drops of it introduced into the mouth will paralyze the nervous system and stop the beating of the heart.[1] We shall now discuss some of the more important effects of nicotin on the body.

**The influence of tobacco on growth.** There are many indications that the processes within the cells that cause growth differ from the processes that go on during the repair of the protoplasm. That is, in cells and in young people that are growing, there are processes going on that are not going on in cells and in persons

[1] Tobacco is from 1 to 4 per cent nicotin. In chewing, only a small part of the nicotin in the tobacco is absorbed into the body, and in smoking, most of the nicotin is broken into other compounds. It is probable that these other compounds produce a large part of the effect that follows smoking. That men smoke to obtain the drug effects of nicotin and of the compounds that come from the nicotin, and not for the physical and mental pleasure of the smoking, is shown by the fact that a smoker is not satisfied with tobacco from which the nicotin has been extracted.

that have reached their full size.[1] Tobacco seems to have an especially evil effect on the processes of growth; for without doubt it is most injurious to the young. Two young guinea pigs that were made to inhale tobacco smoke from the fourth day after birth, on the forty-fourth day weighed 174 and 169 grams respectively instead of 330 grams, which is the normal weight for a guinea pig of this age. One of them died on the forty-fourth day, and the other was not subjected to further inhalations. At the end of the third month this animal weighed only 295 grams. The normal weight at that age is 485 grams, so the animal was still stunted and far below its normal size.

So generally is it known that cigarette smoking interferes with the processes of growth and stunts the young that most of our states have laws forbidding the sale of cigarettes to boys below a certain age. In 1889 the Japanese government became alarmed because of the small size of some of its citizens, and after an investigation of the effects of tobacco passed a law which was worded thus: "Smoking of tobacco by persons under the age of twenty is prohibited." Professor Seaver of Yale University found that of the young men entering Yale during a period of ten years, the smokers averaged 15 months older than the non-smokers, and that notwithstanding their greater age they were one third of an inch shorter and had slightly less lung capacity. The boy who wishes to become large and strong

[1] By experiments on animals it has been found possible to feed them in a way that will keep them alive, but will not cause growth in them. This indicates that the processes of growth and of maintenance are different.

should let cigarettes alone during his growing years, for there is every reason to believe that young smokers fail to reach their full development either of body or of mind.

**The effect of tobacco on the muscles.** As we should expect, tobacco weakens and relaxes the muscles. Professor Lombard of the University of Michigan tested the strength and endurance of his finger muscles on four days on which he smoked five cigars daily; then on four days on which he abstained from smoking; then again on four days when he smoked as on the first days. He found that on the days he smoked, his muscles had lost on an average 41 per cent of their working power.

The fact that tobacco softens and slackens the muscles was so well known before the days of chloroform that patients were prepared for certain surgical operations by giving them tobacco to bring about a relaxed condition of the muscles. At the present time, it is well known among athletes that smoking lowers the strength, and athletes who are in training are not allowed to indulge in tobacco. Cigarettes will surely kill the baseball pitcher's speed; they shorten the flight of the football player's punt; and the tobacco user's muscles weaken and fail when the crowning effort of the race comes.

**The effect of tobacco on the nervous system.** The most serious effects of tobacco are on the nervous system. It interferes with the control of the muscles, and it damages the mind, as we should expect a narcotic to do. The trembling that may be seen in the hands of almost any one who smokes cigarettes to excess shows in a very marked way how tobacco interferes with

the control of the muscles. Because of this effect, tobacco users are not good marksmen with the rifle, and many of them are unable to do delicate work. The following statement by Luther Burbank, the great plant breeder and nurseryman of California, illustrates this point:

"To assist me in my work of budding — work that is as accurate and exacting as watch making — I have a force of some twenty men. I discharge men from this force at the first show of incompetency. Some time ago my foreman asked me if I took pains to inquire into the habits of my men. On being answered in the negative, he surprised me by saying that the men I found unable to do the delicate work of budding invariably turned out to be smokers and drinkers. These men, while able to do the rough work of farming, call budding and other delicate work 'puttering' and have to give it up, owing to inability to concentrate their nerve force. Even men who smoke one cigar a day I cannot intrust with some of my delicate work."

The effect of tobacco on the mind is even more noticeable than its effect on muscular control. A study of the grades of 500 boys in private schools shows that the grades of smokers were on an average 12 to 15 per cent lower than the grades of non-smokers. Another set of statistics covering sixteen schools in different parts of the country and including 800 boys showed that the smokers had fallen on an average 17 to 28 per cent behind those who did not use the drug. A comparison of 50 smokers and 50 non-smokers chosen at random in Kansas State Agricultural College showed that the smokers had averaged 28 per cent lower in grades and

that they had made 74 per cent of all the failures that were made by the 100 boys.

Many other comparisons of the scholarship records of tobacco users and non-tobacco users have been made, and in every case the tobacco users stand far below the others in scholarship. So well known is it that tobacco interferes with good intellectual work that many large corporations absolutely refuse to take into their employ young men who use cigarettes. Judge Stubbs of Indiana gives a list of twenty-two great employers who follow this rule. The list includes Marshall Field & Co., John Wanamaker, and seven great railroads.

**How tobacco affects the mind.** Tobacco undoubtedly injures the mind, so that the person using it learns less rapidly and thinks less clearly. Those who have used it for some time have a tendency to become nervous, restless, unable to remain still for any length of time, and unable to keep their minds concentrated on any one subject. As one writer expresses it, "The mind of a tobacco user seems to lose its grasp of things." It is probable, however, that the main reason why tobacco users fall behind other men in intellectual work is that nicotin steals away ambition. Its first effect on the mind is to lull it to rest; to make one contented with himself and his achievements; to make one satisfied to sit and watch the smoke curl upward while other things take care of themselves.[1] This feeling of ease, comfort, and freedom from responsibility is very pleasurable, and the tobacco habit is the most common of all the drug habits to which man is addicted. In summing up the

[1] "Under the influence of tobacco, thought becomes reverie." — VICTOR HUGO.

good or the evil which comes from a habit of this kind, however, we must always remember that the world's work must be done, and that when a drug for any reason interferes with the working powers of a man, some one else will probably be compelled to do the work which he ought to have done. We must also remember in connection with all drug habits that it is important to know whether we are to be forced to pay with the health of our cells for the pleasurable sensation that the drug gives.

**Other effects of tobacco on the body.** Dyspepsia is very common among tobacco chewers who swallow small quantities of the juice and among those who damage their nervous systems by excessive smoking. Another effect of the continued use of tobacco is to raise the blood pressure, which greatly increases the work of the heart.

Smoking also has a bad effect on the air passages, for the hot ammonia and other compounds in the smoke frequently cause "smoker's sore throat," and cancer of the tongue and throat is more common among smokers than among non-smokers. Besides all these effects on separate organs of the body, the nicotin has a depressing and weakening effect on the body as a whole, just as it has an enfeebling and quieting effect on the mind.

**The effect of a moderate use of tobacco.** In reading this chapter you must bear in mind that not all the evil effects of tobacco that have been described come at once, nor is it possible to observe all of them in every person who is a tobacco user. Small doses of any drug produce proportionately smaller effects than do larger doses, so persons who use tobacco moderately suffer

less from it than do persons who use large amounts. The superintendent of the reform school at Westboro, Massachusetts, says, "All boys sent here have been users of tobacco." The chief probation officer of the juvenile court of Washington, D.C., says, "In dealing with more than 16,000 delinquent children of this city during the last eight years, I find as a rule that the user of cigarettes is a stunt, a weakling in body, mind, and morals." In Chicago, of 2402 cigarette smokers in the grades below the high school, only 6 per cent were doing their school work well enough to pass.

These are the effects of tobacco when used to excess or when used by the young, and persons who have experience with cases of this kind naturally regard tobacco as one of the worst enemies of mankind. Others who see men all about them smoking and yet attending to their work day by day often take the view that after all the tobacco habit is of little consequence. The truth is that some men are born with more health, strength, ambition, and intelligence than others, and that one of these strong men, even after using tobacco for a long time, may still have more strength and brain power than the man who lacked these qualities from his birth.

The question is not, however, whether the strongest tobacco user has more strength than the weakest man who does not use tobacco. The question is whether the strong man is able to use tobacco and at the same time realize the full strength of his body and of his mind. Everything that we know about the effect of nicotin indicates that it is not possible to do this; that it is a violent poison to the cells; that if taken into the body

in large amounts, it will cause death; that if constantly taken during the growing years, it has a very disastrous effect on development; that in any amount whatsoever it has a narcotic effect on the muscles and on the delicate cells of the brain; and that any one who uses it will be damaged by it.

**Why a boy should not use tobacco.** "Your first duty in life is toward your *afterself* — the man you *ought* to be. So live that he in his time may be possible and actual.

"Far away in the years he is waiting his turn. His body, his brain, his soul, are in your boyish hands. He cannot help himself.

"What will you leave for him?

"Will it be a brain unspoiled by lust or dissipation, a mind trained to think and act, a nervous system true as a dial in its response to the truth about you? Will you, Boy, let him come as a man among men in his time? Or will you throw away his inheritance before he has had the chance to touch it? Will you turn over to him a brain distorted, a mind diseased, a will untrained to action?

"Will you let him come, taking your place, gaining through your experiences, hallowed through your joys; building on them his own?

"Or will you fling away his hope, decreeing wanton-like that the man you might have been shall never be?

"This is your problem in life; the problem of more importance to you than any or all others. How will you meet it, as a man or as a fool?

"When you answer this, we shall know what use the world can make of you." — DAVID STARR JORDAN.

## QUESTIONS

Tell of the discovery of tobacco and its introduction into Europe. What different opinions were at first held about tobacco? Name some drugs that are commonly used for their pleasant effects. What effect has a stimulant? a narcotic? Is nicotin a stimulant or a narcotic?

At what time of life is tobacco especially injurious? Describe the experiment in which young guinea pigs were made to inhale tobacco smoke. Why do most of our states prohibit the sale of cigarettes to young persons? Give the results of Professor Seaver's observations on students in Yale University.

What effect has tobacco on the muscles? Describe the experiment performed by Professor Lombard. For what purpose was tobacco used by physicians before chloroform was known? Why are athletes in training not allowed to use tobacco?

What effect has tobacco on the nervous system? Why are users of tobacco not good marksmen? Repeat what Luther Burbank said about his workmen. Give statistics showing mental progress made in schools by smokers and by non-smokers. What rule have many great employers made regarding cigarette smokers? How does tobacco affect the mind? the digestive system? the arteries? Discuss the effect upon the body of a moderate use of tobacco.

## SUGGESTIONS TO THE TEACHER

If possible, teach this chapter in an informal manner, discussing local conditions when it is possible to do so. Statistics as to the use of tobacco by the athletes and high scholarship students of the school may quickly be gathered, and the attitude of local employers may sometimes be mentioned. The continued use of cigarettes by the young can only be ascribed to ignorance concerning the results of their use, and the question will form an excellent subject for discussion at a parents' meeting. The *Scientific Temperance Journal,*

Boston, Massachusetts, prints much information on this subject that is of value to the teacher. The price of this journal is 60 cents a year.

Emphasize again the importance of forming correct habits and how tobacco interferes with the formation of habits of industry. In case a good student has recently begun the use of tobacco, call his attention to the fact that his previously formed habits of study are still keeping his class standing high, but that he should be on the alert for signs of the drop in his scholarship record that will in all probability come if the use of tobacco is continued. An interesting side topic is the early history of the use of tobacco in Europe. The securing of the concessions for its sale by Sir Walter Raleigh and his efforts to extend its use so that his revenues from it might be increased, have much of human interest in them.

# CHAPTER TWENTY-ONE

## ALCOHOL

A STANDARD text on hygiene that was used in many of our medical colleges as late as 1890 taught that malaria was due to miasma from swamps; that typhoid fever was connected with the rise and fall of ground water; that cholera seemed to be related to the temperature of the soil from four to six feet below the surface; that erysipelas was due to impurities in the air; that diphtheria was caused by sewer gas; and that yellow fever was an air-borne disease.

These ideas seem strange to us today, but the fact that they were current so recently even among medical men emphasizes the fact that in the past men have looked upon disease as something that comes upon us from without; that they have thought of the causes of sickness as lying in the world about us. Now we have come to understand that the causes of ill health are to be sought for, not in the swamps and forests and changes of weather, but within the body itself; that it is what goes into the body rather than the distant outside world that is important in hygiene. We have learned that the great secret of health is to keep the lymph in which the cells are bathed free from poisons and impurities and to allow the cells to live their own lives in a natural way.

Along with this new knowledge there has come a truer understanding of the uses of medicines and a greater care about taking into the lymph strong drugs whose effects on the delicate cells are not fully understood. The best physicians now realize that all medicines are foreign and unnatural substances in the lymph, which ought to be given only when there is good reason

to believe that the body will be benefited by them; and they are continually amazed at the reckless and ignorant way people pour patent medicines and other strong drugs in upon their cells. In this chapter we shall study the effects on the body of the use of alcohol, a powerful drug that is extensively used by the people of our country.

**Where alcohol comes from.** *Yeast* is a small plant that lives on the skins of fruits and in very rich earth, and that often blows about in the air. The favorite food of this small plant is sugar, and when it falls into a liquid that contains sugar, it grows and multiplies very rapidly. In doing this it uses the sugar for food and breaks it up into water, carbon dioxid, and alcohol. This process is called *fermentation.* The alcohol in all the different kinds of intoxicating drinks that are used by man comes from the fermentation of sugar by yeast.

**Different kinds of alcoholic drinks.** The natives of the tropics cut off the flower clusters of palm trees and collect the juice that pours out from the cut ends. This contains much sugar, and after it has been fermented it contains great quantities of alcohol. The Mexicans collect the juice of the *agave,* or century plant, in the same way and manufacture an intoxicating drink from it. Fruit juices are rich in sugar, and in temperate countries the people make wine by allowing them to ferment. Grapes, apples, currants, and blackberries are the fruits that are most commonly used for this purpose. In the manufacture of beer, grain is soaked in water until it sprouts, and the starch in it is digested to sugar and dissolved out in water. Yeast is then allowed to change the sugar in the liquid to alcohol.

Rum is made by fermenting molasses and distilling off the alcohol; whisky is made by distilling the fermented liquid from sprouting grains; and brandy is made by distilling fermented fruit juice.[1] Alcoholic drinks have different tastes, according to the substances from which they are made, and some are stronger than others, but in all of them it is the alcohol itself that is the important thing.

**The use of alcohol injurious to the body.** Is alcohol injurious to the body? In the past there has been a division of opinion on this point. Today we have come into an age of science, and we are substituting knowledge for guesswork in all fields of human thought. What are the facts in this case? Does taking alcohol among the cells cause the body machine to run a longer or a shorter time, and is it laid up for repairs more days or fewer days in a year when alcohol is used? The following statistics will give us some information on the question.

**The effect of alcohol on health and length of life.** In Australia the workmen have benefit societies that pay wages for time lost on account of sickness. The records of these societies show that the members of societies that admit only abstainers lose but little over half as much time on account of illness as do the members of societies that admit drinkers. This indicates that the use of alcohol increases sickness. A number of life in-

[1] In distilling liquors, the liquid (the fruit juice or the water in which the grain has been soaked) that contains the fermented sugar is heated, and the vapor that comes from it is caught and condensed. The alcohol in the liquid is changed to vapor more easily than water, and the liquors that are manufactured in this way are strong in alcohol.

surance companies have kept records of the deaths of the abstainers and drinkers among their policy holders separately. When these records are examined, the results are always the same, — the death rate among the drinkers is higher than it is among the abstainers. The following examples taken from recent reports of insurance companies will illustrate the point.

In the ten-year period from September 30, 1900, to September 30, 1910, the experience of the Australasian Temperance and General Life Insurance Society showed that where there were 100 deaths among drinkers there were only 62 deaths among abstainers. The Manufacturers' Life Insurance Company during the nine-year period from 1902 to 1910 inclusive had a death rate of 56 among abstainers as against 100 deaths among an equal number of drinkers. For a twenty-eight-year period, ending in 1911, the Sceptre Life Insurance Association had 67 deaths among its non-drinking policy holders, where it had 100 deaths among its non-abstaining members. All other records that have been kept show that there are more deaths among drinkers than among an equal number of abstainers of the same age.[1]

[1] "There may be some actuary in the world who believes that total abstainers do not live as long as non-abstainers, but I never heard of one, and I have never seen any figures showing an advantage in favor of abstainers of less than 21 per cent. Certainly, adding one fifth to a man's life makes it worth while to forego one class of food or drink.

"Some years ago I secured an opinion of an actuary on the expectation of life of a young man of twenty who was a total abstainer and of one who was a drinking man at that age. The expectation of the abstainer was 42.2 years; of the drinking man, 15 years." — EDWARD A. WOODS, an insurance manager, quoted in Dr. Henry Smith Williams' *Alcohol: How it affects the Individual, the Community, and the Race.*

We can therefore decide that alcohol used as men ordinarily use it causes sickness and shortens life ; and since this is true, it must also be true that it is injurious to the cells.

**The effects of alcohol on the structure of the cells.** Alcohol causes *fatty degeneration* and *fibroid degeneration* of certain of the tissues.[1] In fatty degeneration little droplets of oil begin to collect within the cell, and gradually the living protoplasm of the cell is replaced by fat, until sometimes the cells become mere bags of oil. When the cells of the gastric glands are changed in this way, they lose their power to secrete ; when the muscle cells of the heart are changed to fat, they lose their strength ; when the walls of the arteries are affected, they are, of course, weakened ; and when there is fatty degeneration of the liver, kidneys, or nerve fibers, we must expect these organs to fail in their work.

The tissues most commonly affected by fibroid degeneration are those of the liver, kidneys, arteries, heart, and brain. In this kind of degeneration there is an overgrowth of the connective tissue elements, while the working cells degenerate and die. Often in the arteries the elastic muscle coat is not only changed to connective tissue, but lime is deposited in the walls. These changes make "pipe-stem" arteries, which are brittle and often have the opening in them narrowed until it is with great difficulty that the blood makes its way through them.

[1] As we shall explain later (pages 452–453), there is good reason to believe that in some of these changes in the tissues it is intestinal toxins rather than the alcohol that really causes the trouble, but since it is the drinking of the alcohol that causes the toxins to be formed, the fault in the end goes back to the alcohol.

**Some diseases that may be caused by alcohol.** In the United States each year there are about 4,000 deaths that are directly due to the use of alcohol. Certain diseases, moreover, are more common among drinkers than among abstainers, and it is believed that much sickness and many deaths are due to accidents and diseases that are brought on by the use of alcoholic drinks.

Prominent among the causes of death that are connected with the use of alcohol are: hardening of the liver, in which the liver turns to connective tissue and shrinks into a small, hard organ utterly incapable of doing the work which it is supposed to do; diseases of the kidneys, in which these organs degenerate and fail in their work of excreting the poisonous wastes; heart disease, which may take many forms; hardening of the arteries; apoplexy and paralysis, which are due to the bursting of blood vessels in the brain; insanity and other diseases of the nervous system; tuberculosis, pneumonia, and other germ diseases, to which the user of alcohol falls a victim because he has weakened the defenses of his body; and accidents that would never have occurred had not some one been under the influence of drink.

It will be noticed that the chief effects of alcohol, aside from those on the nervous system, are on the heart, blood vessels, lungs, stomach, liver, and kidneys, — the great internal organs that supply the body with food and oxygen and dispose of its wastes. When we remember how the life of the whole body requires that the work of these organs be efficiently performed, it is easy for us to understand that anything that injures them is of first importance in the realm of health.

**The effects of a continued moderate use of alcohol.** It should be understood that, except for certain effects on the brain, we are discussing in this chapter the effects of what is called moderate drinking on the body; for when alcohol is used day after day, even though it be used very moderately, there is a piling up of its effects on the tissues. Indeed, the cells of the man who drinks a moderate amount of beer or wine daily are never free from the influence of alcohol. Beer drinkers suffer most of all from fatty degeneration of the tissues, and one need never become intoxicated to experience the evil effects from alcohol that have been described above.[1] The shortening of life given on page 407 is in moderate drinkers and not in drunkards; for the death-rate among those who habitually drink to intoxication is so high that no insurance company will accept them.[2]

**The effects of alcohol on the mind.** Because alcohol causes a person to seem lively and to talk more easily, it is commonly believed that it is a stimulant. This is a mistake. Alcohol is a narcotic, and it produces its seemingly stimulating effect by paralyzing the higher

[1] "Alcoholic diseases are certainly not limited to persons recognized as drunkards. Instances have been recorded in increasing numbers in recent years of the occurrences of diseases of the circulatory, renal, and nervous systems, reasonably or positively attributable to the use of alcoholic liquors in persons who never became really intoxicated and were regarded by themselves and others as 'moderate drinkers.'"

— DR. WILLIAM WELCH.

[2] A few of those classed as drinkers may have become heavy drinkers after they were insured, but insurance companies reject not only drunkards, but also those who seem likely to become drunkards. The comparison is, therefore, in the main between abstainers and moderate drinkers.

centers of the brain and allowing the person to do and say things that ordinarily his good sense keeps him from doing and saying. In one set of experiments it was found that 20 to 40 grams of alcohol (the amount in from one to two quarts of beer) taken on twelve successive days lessened the capacity to add numbers 40 per cent and the ability to memorize poetry 70 per cent.

Other experiments show that the capacity to think clearly and to judge correctly is greatly influenced by even small quantities of alcohol. Typesetters who were given only a little over an ounce of alcohol a day did 10 per cent less work and made 25 per cent more mistakes than on days when no alcohol was taken, and the effect of these small doses of alcohol continued 48 hours.

After taking a drink, a man feels that his mind is working better and that his ideas come more easily and freely. The truth is that his mind is slower and his ideas are less sensible than usual, but the powers of his mind by which he judges of these things have been deadened by the alcohol, and he is no longer capable of forming a correct opinion of his own acts.

**The effect of alcohol on the strength and control of the muscles.** The man who has taken alcohol always feels that he is stronger and has more endurance because of it. In this case, again, the alcohol user is mistaken as to his real condition, as facts like the following prove:

About sixteen years ago, Professor Durig, a chemist and an expert mountain climber, carried on a series of experiments by repeatedly climbing a peak in the Alps. On certain days he drank alcohol equal to the amount in two glasses of beer; on other days no alcohol was taken. He was accustomed to use moderate

amounts of alcohol, and he felt that he worked more easily on alcohol days, but to his surprise he found that on those days he expended 15 per cent more energy and required more than one fifth longer to climb the mountain. Other tests carried on for ten days in the laboratory showed that two glasses of beer taken at dinner reduced the working power of the muscles 10 per cent. "Alcohol gives, not strength, but only a feeling of strength, to the muscles." It deadens the ability to feel fatigue, but does not relieve fatigue.

It is probable that the weakening effect of alcohol on the muscles is mainly due to its interference with their control by the nervous system. The movements are made awkwardly, and the muscles work against each other, and so much of their power is lost. This lack of fineness of control in alcohol users is shown at once in a baseball pitcher, a bowler, a rifleman, or any one who does work that requires each muscle to work exactly the right amount and at exactly the right moment.

**Why alcoholic drinks have been banished from the United States.** When the Great War came and nations were put to the test, practically all those that were called on to put forth all their effort restricted the manufacture and sale of alcoholic drinks. No argument was needed to convince the peoples that the manufacture of intoxicating drinks was a waste of foodstuffs and their use a hindrance in the prosecution of the war; deep within their consciousness they knew that alcohol was an evil. They were shaking off everything that would hinder them in the great fight and they knew that the use of intoxicating drinks would sap the

strength and becloud the minds of those who needed clear intellects and strong bodies for the struggle.

Now that the war is over the people of our own country have decided that intoxicating drinks shall be sold in it no more. Some of the reasons that moved them to this decision have been set forth in this chapter. The majority of them were convinced that alcohol is injurious to health, morals, and efficiency, and they saw no reason why in times of peace any more than in times of war an unnecessary burden should be imposed on our land. After seventy-five years of discussion of the question our people, through their representatives, have declared that the time when intoxicating drinks can be sold in the United States has passed. This decision is doubtless wise; the combined judgment of an intelligent people on any question with which they have long been familiar is usually correct. Once again America has led the way, and in time the other great nations of the earth will doubtless follow the example she has set.

### QUESTIONS

How is alcohol produced? How is alcohol made in the tropics? How is wine made? How is beer made? Name some distilled liquors.

What effect has the use of alcohol on the health? Give statistics showing its effect on the death-rate.

Explain what is meant by fatty degeneration. What organs may be affected in this way? What changes take place in fibroid degeneration? What organs are commonly affected in this way? Explain the result of fibroid degeneration of the arteries.

In the United States how many deaths each year are due to

alcohol? How many are directly caused by alcohol? Name some diseases that are often caused by the use of alcohol. What organs of the body are most affected by the use of alcohol? What effects has moderate drinking on the body?

Why is it commonly believed that alcohol stimulates the mind? What effect have small amounts of alcohol on the power to add numbers? to memorize? Describe the experiment in which typesetters were given small amounts of alcohol.

Explain the effects of alcohol on the muscles.

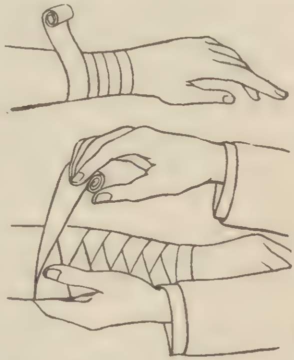
## SUGGESTIONS TO THE TEACHER

In teaching this chapter, nothing is so important as to get the facts before the pupils. The two most easily accessible sources of facts in regard to the effects of alcohol are Dr. Henry Smith Williams' *Alcohol: How it Affects the Individual, the Community, and the Race* (The Century Company, New York) and the numbers of the *Scientific Temperance Journal* (see page 420). This journal gives, through summaries and abstracts, the results of scientific experiments in this field and translates articles dealing with the very important work that is now being carried on in different European countries

# CHAPTER TWENTY-TWO

## ACCIDENTS

"In time of peace prepare for war." In every house there should be kept in a small box or drawer certain articles for use in case of accident. Among these articles should be soft, worn-out towels; cotton or linen cloths three to six inches square; rolls of bandages varying from one half inch to three inches in width and from one to two yards in length; a bar of green soap; threaded needles, scissors, and safety pins; borated vaselin; bichlorid or biniodid of mercury disks; powdered boracic acid; and a bottle of collodion. Accidents come without warning, and having these supplies ready may save suffering or even life.



FIGS. 138 and 139. Showing a circular bandage and the method of reversing a bandage.

**Bandages.** Since many small hurts are treated without the aid of a physician, it is well to understand how to put on a bandage neatly, comfortably, and securely. When the part that is to be bandaged is of nearly the same circumference throughout, the bandage should simply be rolled around the part from below upward, each turn of the cloth covering two thirds of the one below. When the part that is to be bandaged is thicker in one part than in another, as the forearm or leg, the bandage may be made to lie smooth and flat by reversing each turn after the first few turns. To reverse a bandage, hold it at its lower edge and turn it one half

over towards you. To give a neat appearance, make each reverse directly above the one preceding it. The figure-of-eight bandage is useful about joints. The best way to get an understanding of the different bandages here described is to study the illustrations in Figures 138 to 143. After two turns have been put on, the bandage should be firmly stitched, and, after the bandage is completed, the end should be securely sewed. A row of stitches from top to bottom, one in each turn of the bandage, is of great advantage in preventing slipping. Always bandage firmly, but never too tightly, and use an equal pressure throughout the bandage.

FIGS. 140, 141, 142, and 143. A reversed bandage and a figure-of-eight bandage on the hand; a figure-of-eight bandage and a reversed bandage on the foot.

**Wounds.** It is well that a cut should bleed freely, as the blood assists in washing out and killing any germs that may be in the wound. If the cut has been made with a clean instrument, it may be bandaged without any treatment at all, or bandaged after being dusted with powdered boracic acid. A wound made by an unclean instrument should be washed with soap and water and treated with powdered boracic acid or borated vaselin. If the person must use

the injured part in attending to his work, two bandages should be put on. The outer one may be changed when it is soiled, but unless the wound becomes red and painful and has matter in it, the inner bandage should be left undisturbed until the injury has healed.

Deep wounds, such as are made by rusty nails that have become soiled by lying about barnyards, are dangerous, because frequently tetanus germs get into them. A puncture or other wound that is so deep that it cannot be thoroughly cleansed ought to be treated by a physician, who will know whether it is advisable to use tetanus antitoxin as a safeguard against danger from tetanus germs.

**Bleeding**. When blood flows in jets and has a bright red color, an artery has been cut. If the blood flows in a steady stream, it is a vein that has been severed. In either case, a physician should be called at once. In the meantime, control the bleeding by pressing on the vessel with the thumbs. The pressure should be applied between the wound and the heart if the cut vessel is an artery; beyond the wound, if the bleeding is from a vein. If the physician is long in coming, or if the bleeding cannot be controlled by pressure with the thumbs, twist a handkerchief about the limb, as shown in Figure 144. The blood should not be shut off from the limb for longer than an hour, as much damage may be done by

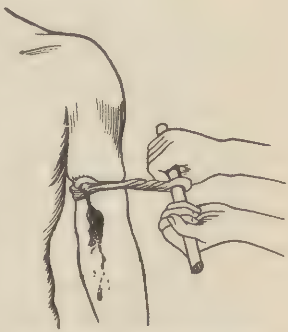


FIG. 144. Checking bleeding from a wound.

depriving the cells of their supply of blood for too long a time.

**Blows on the head**. A blow on the head sometimes ruptures a blood vessel within the cranium and causes a blood clot to form on the brain. If a person becomes sleepy after such a blow, a physician should be called at once. It is well to wake the person occasionally during the night after such an injury; for otherwise he may sink into unconsciousness without its being discovered.

**Burning clothing**. If your clothing should take fire, *do not start to run*. If possible, remove the burning garment at once. If this cannot be done, remember that a fire cannot burn without air, and that the quickest way to put out burning clothing is to lie down and wrap yourself in a blanket or rug, or in anything else that you can lay hands on. If nothing is at hand that can be used as a covering to smother the fire, lie down and roll over and over. In any case, *lie down* so that the flames will not come up about your face; for inhaling a flame is often followed by very serious consequences. In passing close to a fire, as in a burning building, the face should be protected if possible by something held before it.

**The treatment of burns**. A burn in which the skin is only reddened, or in which the blistering is slight, may be treated by simply shutting the air away from it. A paste made of baking soda and water, or of flour or starch mixed with water, is good for this purpose. White of egg, vaselin, olive oil, castor oil, fresh lard, or cream may also be used to cover a burn. Wet cloths wrung out of cold water will help to allay the pain. Burns which cover much surface, or small, deep burns, should be shown to a physician; for it is not always

possible to tell at first how much damage has been done, and the injury may be more severe than it appears to be.

A burn made by an acid should be washed and treated with limewater, baking soda, or soapsuds. A burn made by an alkali (such as lime, lye, etc.) may be treated, after thoroughly washing off the alkali, with weak vinegar, lemon juice, sour milk, or buttermilk.

**Apparent drowning**. Drain the water from the patient's lungs by catching him under the waist and holding him for a few seconds with the head hanging down. Then quickly lay him in the position shown in Figure 145, with a folded coat or blanket under his chest. Place the hands on either side of the back over the lower ribs. Throw the weight of the body steadily downward on the hands and drive the air out of the lungs. Take the pressure off the body without lifting the hands, and allow the air to come into the lungs. Repeat about fifteen times a minute. This method sends more air through the lungs than any of the methods in which the patient is laid on his back, and it has the additional advantage that the tongue does not fall back and block the throat.

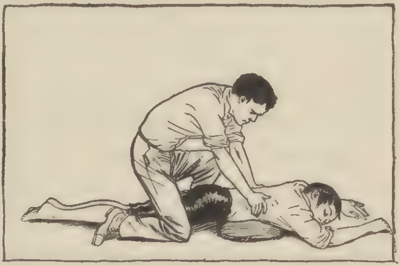


FIG. 145. Carrying on artificial respiration.

Rubbing the limbs along the veins toward the heart causes the blood to circulate and should be kept up if there is a second person to attend to it. Keep the

patient as warm as possible by covering him with a blanket and pouring warm water over him, or by laying hot-water bottles about him. A hot-water bottle at the head is especially important, but nothing hotter than can be borne comfortably by the skin of the elbow should be brought into contact with an unconscious person. When the patient begins to revive, give strong hot coffee, or fifteen drops of ammonia in a glass of water. Artificial respiration should be kept up for an hour or longer if the person does not recover sooner.

**Suffocation.** Suffocation may be produced by hanging, by choking, or by gas or smoke poisoning. Sprinkle cold water on the face; carry on artificial respiration as in cases of apparent drowning; and, when the person is able to swallow, give stimulants as directed above.

**Fainting.** Lay the patient flat on his back, so that the blood will flow easily to the head. Sprinkle cold water on the face, and give him fresh air. Give strong coffee or ammonia as directed above.

**Dangers from electricity.** As the use of electricity becomes more common, it is more and more frequently a source of accidents. Even now many people do not seem to know that highly charged electric wires and third rails are deadly affairs, and that those who do not understand their workings ought not to take chances with them. Where a notice is posted warning the public not to cross the track of an electric line, there is a reason for the warning, and you should keep off the track. When a trolley wire or an electric wire breaks and falls to the ground, keep away from it. It is interesting to experiment with electricity, but you cannot afford to begin in this way.

**Rescuing a person from an electric wire or a third rail.** A live wire lying on a person may be safely flipped off with a dry board or stick. If the person is lying on the wire, the wire may safely be cut with an ax or hatchet that has a dry wooden handle. Cut between the person and the source of the electricity; on both sides, if the source of the electricity is unknown.

In trying to pull a person off a live wire or third rail, great care is necessary or the rescuer will be injured. In attempting to do this, unless the ground is very dry, one should stand on a dry board, a folded coat, or several thicknesses of folded newspapers. A rubber mat is better than the articles just mentioned, but it is not often at hand. If possible, take hold of the person through dry cloth or paper, and catch him by the clothing without allowing the hand to come into contact with his body. Pull him off the rail or wire with one quick, firm motion, and if he is not breathing, carry on artificial respiration as in cases of apparent drowning. A doctor should be sent for as quickly as possible.

**Foreign bodies in the eye.** If a cinder or other foreign body gets into the eye, do not rub the eye. Keep it closed and the tears will often wash the dirt out into view so that it may easily be removed. Sometimes stretching the upper lid down over the lower lid two or three times, or closing the nostril on the opposite side and blowing the nose hard, will change the position of the object and make it possible to remove it. The inner surface of the lower lid may be examined by pressing the lid down, and some persons are skillful enough to turn the upper lid back over a match or small stick so that the offending particle can be wiped off. Only

clean fingers, clean handkerchiefs, or other clean objects should be allowed to touch the eye. After the foreign body has been removed, a few drops of boracic acid solution is soothing and is useful in safeguarding against possible infection with germs.

**Foreign bodies in the nose and throat**. Little children sometimes push beans, peas, beads, or other objects into their noses. Having the child blow the nose will often bring these objects out, but if they cannot be removed in this way a physician should be called. Do not try to remove them with a hairpin or other sharp instrument.

When a button, coin, or other object sticks in the throat, the child should be seized by the feet, suspended head downward, and energetically shaken and slapped on the back. Usually this will cause the object in the throat to drop out.

**Treatment for swallowed pins and needles**. When a pin or needle has been swallowed, a large meal of bread, potatoes, cabbage, or other coarse foods should be eaten, as they will leave a large amount of undigested matter to coat the foreign object during its passage through the alimentary canal. *Never give a laxative under such conditions*. No anxiety need be felt over swallowed buttons, coins, and other similar objects.

**Frostbite**. Keep away from the fire and thaw the "bitten" part out very gradually by rubbing it with snow, or by keeping it bathed in ice water until the blood begins to circulate through it again. Suddenly thawing the frozen tissues is far more injurious than the freezing, and every care should be taken to keep in a cool atmosphere until the thawing process is completed.

**Ivy poisoning.** Dissolve a level teaspoonful of potassium permanganate crystals in a pint of water and bathe the affected parts. Before the skin is broken

FIGS. 146 and 147. The poison ivy is often mistaken for the Virginia creeper. The Virginia creeper has five leaves, while the poison ivy has only three.

the poisonous oil may be partially removed at least by thorough washing with strong soap or with alcohol. In severe cases a physician should be consulted.

**Poisoning**. *Bottles that contain poisons should not be kept among medicines*, and it is well to paste strips of sandpaper on such bottles, so that they can be recognized even in the dark. When a poison is taken by accident, a physician should be called immediately. If possible, have the messenger tell him what poison has been taken, so that the proper antidote may be brought.

A card with a list of the different poisons and their antidotes should be written out, and placed with the other articles that are kept for use in case of accident. The sooner the antidote is given, the less time will the poison have to damage the body, and when one is thus prepared, a case of poisoning can often be treated before the doctor arrives.

While waiting for the doctor, give an emetic at once to produce profuse vomiting, if the poison is not an acid. Good emetics are: mustard and water; salt and water; lukewarm water alone and in large quantities; and ipecac. Tickling the throat with a feather or thrusting the finger into the throat will help to cause vomiting.

The following list of antidotes for some of the more common poisons may be found useful:

*Acids*. Give soda, chalk, old mortar, or soap. Oil and milk are useful. For carbolic acid use alcohol (whisky or brandy will do). Oil or milk should be used if no alcohol is at hand.

*Arsenic*. This is the poison in Fowler's Solution, Paris Green, and Rough on Rats. Give any medicine that contains iron.

*Mercuric chlorid*. This is also called bichlorid of mercury and corrosive sublimate. Give milk, white of egg, or both. Flour or starch with milk and egg is good.

*Phosphorus*. Magnesia and chalk in water, and white of egg are good remedies. *Do not give oil or milk*. Phosphorus is the poisonous substance on the end of matches, and is often found in rat poison.

*Opium, laudanum, nightshade, and jimson weed*. Give strong coffee or ammonia. Keep the patient awake by walking him about, slapping him, or throwing cold water over him, if necessary. Give stimulants as directed under Fainting, on page 438.

*Strychnin*. Inhaling chloroform or ether will quiet the patient. Give five grains of sodium bromid every half hour. Keep the patient away from cold drafts and noises, and allow nothing to touch him, as any stimulus makes the spasms more violent.

**Preventing accidents**. The first step in preventing accidents is so to arrange the conditions under which we live and work that it will be difficult for mishaps to occur. In machine shops and factories and on railroads, this is rapidly being done. The causes of accidents in private homes and on farms should also be removed; for many houses are built with dangerously steep cellar stairs; many barn lofts can be entered only by climbing rickety ladders; stairways and openings in floors that are left unprotected by railings are the cause of many falls; and farm machinery is constantly being operated in a dangerous and careless way. All these and other conditions that cause accidents should be remedied, and when this is done the number of accidents is at once greatly reduced.

The other important factor in the prevention of accidents is the use of intelligence and reasonable care when it is possible for carelessness to cause an accident to happen. In our cities children are continually running directly in the way of automobiles and street cars; drownings occur because of a lack of care in handling boats and because persons who cannot swim venture into water beyond their depth; clothing is set ablaze by standing too near an open fire; and automobile accidents occur because of recklessness in driving these machines. Accidents of this kind can only be prevented by intelligence and watchfulness, and you should constantly educate yourself in those habits that prevent them.

More people are injured by falling than in any other way, and the most common cause of falls is carelessly placed ladders. An ordinary ladder should not be set

too straight or too slanting, and a three-legged stepladder stands more securely than a four-legged one.

The problem of accidents is more important than is generally understood (Fig. 148), as in addition to the killed, hundreds of thousands of persons are injured in them each year.

### QUESTIONS

Name some articles that should be kept for use in case of accident. Name three kinds of bandages and tell how each is put on. Describe the treatment for cuts. Why is a deep wound made by an unclean instrument dangerous? When blood is flowing from a wound, how can you tell whether it comes from a vein or an artery? How can the bleeding be checked until a physician arrives?

Why should a person not be allowed to sleep uninterruptedly after a blow on the head? If your clothing were to catch fire, what should you do? Describe the treatment of burns. Describe artificial respiration. When should it be used? In addition to carrying on artificial respiration, what else may be done in cases of apparent drowning? What should be done in cases of suffocation? What should be done for a person who has fainted?

Tell how a person may be rescued from a live wire or a third rail. How may foreign bodies be removed from the eye? from the nose? from the throat? What is the treatment for swallowed pins and needles? for frostbite? for ivy poisoning? Give antidotes for the following poisons: carbolic acid; arsenic; mercuric chlorid; phosphorus. Give the treatment for a case of strychnin poison. In what two ways can accidents be prevented.

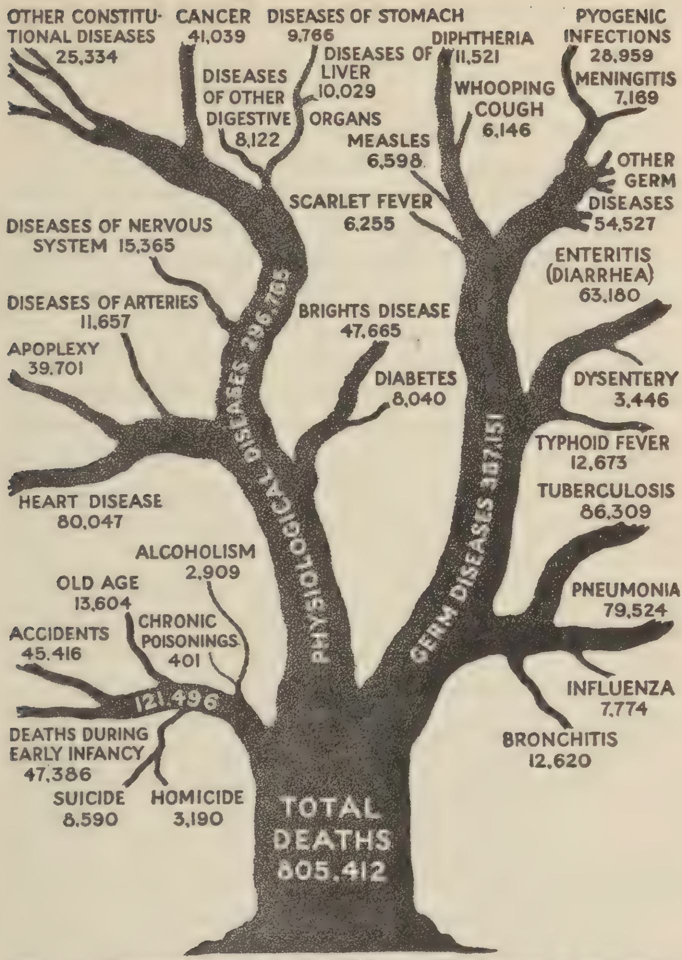



FIG. 148. Estimated number of deaths from various causes in one year in certain states and cities in the United States. Germs are of more importance than the diagram shows, for slow infections of the heart, kidneys, and other parts are the primary cause of many deaths listed as physiological diseases. Estimates from the 1920 Census reports give about 1,400,000 deaths in the whole U. S. A. yearly, 600,000 of which are considered preventable.

# CHAPTER TWENTY-THREE

## REALIZING HEALTH POSSIBILITIES

When a farmer begins to study how to increase his harvests, one of the first facts he learns is that it is the "limiting factor" that determines what the growth of his crops shall be. An exact definition of what a limiting factor is would mean little either to the average farmer or to you, but an illustration makes it easy to understand the meaning of the phrase.

Suppose that in an acre of land there is enough nitrogen to raise 75 bushels of corn, enough phosphorus to raise 20 bushels, enough potassium and other needed elements to raise 100 bushels, and that the season is favorable and there are rain and sunshine enough to make 100 bushels. What will the crop be? It will be 20 bushels.

The phosphorus is the limiting factor that makes it impossible for the yield to rise above that point. A chain is no stronger than its weakest link, and it is not the half dozen favorable factors, but the one unfavorable one, that determines what the harvest shall be. The important thing for the farmer to do, therefore, is to find the factor that is limiting his crop and strengthen the weak point. Otherwise the abundant supply of water and of nitrogen and other plant foods in the soil is of no value to him.

**The limiting factor in health.** The health of the human body is dependent on many different things. *All* of these are necessary, and if any one of them is lacking, it will be the limiting factor that will make health impossible no matter how many other conditions may be favorable. One person may have good food, fresh air,

and everything else necessary to health except sufficient sleep. In other cases the limiting factor may be the condition of the teeth, adenoids, lack of exercise, lack of fresh air, alcohol, overwork, or improper food. With many persons everything necessary for health is present if only disease germs could be kept out of the body.

In some cases more than one difficulty must, of course, be removed before health can be achieved, but often only one factor makes the difference between illness and health. In our quest for health, it is, therefore, most important that we neglect none of the factors that are necessary for a realization of our health possibilities. To give you some wider ideas that may serve as guiding principles in your search for limiting hygienic factors in your own life, we shall in this final chapter discuss in a more general way the causes of sickness and how they may be avoided.

**Two classes of diseases.** Diseases may be divided into two great classes, — *germ diseases* and what may be called *physiological diseases*. In those of the first class, the difficulty is that germs are growing in the body and poisoning the cells. In diseases of the second class, the trouble is in the body itself. Some organ like the heart or the liver fails in its work and the body is like an engine with a broken part. Germ diseases are in the main diseases of early and middle life, while physiological diseases usually come on only in later life when the organs and tissues begin to wear out. Figure 148 will give you an idea of some of the more important of the diseases belonging to each of these classes.

**The cause of germ diseases.** Disease germs are

either bacteria, which are very small plants, or they are little animals that live in the body. Like other living things, germs must have food, and they grow in the body because in it they can find the food supply and the warmth that they need. Unfortunately for both them and us, however, disease germs produce toxins in their bodies that poison our cells. These toxins throw out of order all the life processes of the cells, and in some diseases like diphtheria and scarlet fever the cells in vital organs like the kidneys and the heart may in a very few days become soft and mucilage-like, and many of them may undergo fatty degeneration (page 426).

From the diagram on page 445 you will see that germ diseases are responsible for practically one half of all the deaths in the United States, and they do even more damage than this indicates; for an attack of diphtheria at ten years of age may weaken the heart until it will fail when the person reaches fifty years of age, scarlet fever in childhood may start trouble in the kidneys that will lead to Bright's disease in later life, and it is a common thing for typhoid fever to wreck the health for all time. Insurance companies that have tried issuing policies on the lives of reformed drunkards have found the death rates exceedingly heavy. Even when the drinking is stopped, the effects of the alcohol that has been consumed in years past cannot be removed. So even though a person is not killed outright by an attack of germ disease, it is nevertheless true that his cells are often damaged by the toxins until they never recover. Germ diseases, therefore, are of far more importance than the mere number of deaths caused by them shows.

**How the body resists disease germs.** For our resistance to many germs, we depend on the white corpuscles of the blood, which swallow the germs and destroy them. At times the corpuscles are very active; at others they seem to lose all interest in germs and lie inactive when the germs are growing all about them. It has been found that this difference in the activity of the corpuscles depends on whether or not there are *opsonins* in the blood. What these are or where they come from is not known exactly, but in some way they seem to make the germs more appetizing to the corpuscles and cause the corpuscles to take them in. There is a different opsonin for each different kind of germ, so that one may have plenty of opsonin for the tuberculosis germ, and little opsonin for the pneumonia or the grip germ.

In other diseases the germs are killed in the body by a *germicidal substance* which is formed in the cells and appears in the lymph and the plasma of the blood. This dissolves and kills the germs, and is even more important as a defender of the body than are the white corpuscles. As in the case of the opsonins, there is a different germicidal substance for each different kind of germ that is killed in this way. After certain diseases the germicidal substances remain in the blood for years or even for life, and we usually suffer from these diseases only once.

**The relation of good health to disease germs.** The power to resist germs depends on having in the blood opsonins and germicidal substances for the germs. These are naturally present in the blood of the average person only in very small amounts, and merely being in good health does not seem to increase these amounts.

If, however, germs are introduced into the body, the presence of the germs causes the body to begin the manufacture of opsonins and germicidal substances to combat them.

The way to secure immunity to a disease, therefore, is to have the disease, or to introduce into the body weak or dead germs of the kind that causes it. This is what is done in vaccination for smallpox, typhoid fever, plague, boils, catarrh, and a number of other diseases. We cannot secure this immunity through good health alone, as is proved by the fact that diseases like measles, typhoid fever, cholera, plague, smallpox, and diphtheria attack the strong as readily as they do the weak.[1]

It must not be concluded from the above, however, that care of the body is of no importance in dealing with germ diseases. It is true that we cannot depend on good health to keep us from taking these diseases, but after we have them the body has the task of manufacturing enough opsonins and germicidal substances to kill the germs.

It is reasonable to suppose that a vigorous, healthy body can do this more rapidly than can a feeble body,

[1] There is a widespread notion, even among physicians, that if one will keep himself in good condition he will be able to "throw off" any dangerous germs that may get into his body. Unfortunately, this theory does not seem to be in accordance with the facts. Studies made on the soldiers who contracted typhoid fever in the camp at Chickamauga during the Spanish-American war showed that these men were no weaker than those who escaped the disease, nor were they sick or out of condition before the fever came upon them. Laboratory tests show that only about one fourth of the rats of San Francisco are susceptible to plague. There is no reason to believe that the animals that take the disease differ in any way from those that escape it, except in their lack of the germicidal substance which kills the plague germ.

and even though a strong body does not protect us from acute infections, it ought to withstand the strains of illness better than a body that has been weakened through lack of care. Moreover, in slow diseases like tuberculosis, catarrh, bronchitis, chronic colds, malaria, and chronic infections of many kinds, the body has plenty of time to manufacture its protecting substances, and a vigorous condition of the health is of the highest importance in helping us combat ailments of this kind.

Nevertheless, it remains true that the way to avoid germ diseases is to keep the germs out of the body; that as long as germs are allowed to be scattered about they will find millions of victims who cannot resist them; that the great victories for health that have been won in recent years have been won mainly by preventing the spread of infectious diseases, and that more can yet be done for the health of the world by fighting germs than in all other ways combined.

**Physiological diseases.** The causes of many of the ailments classed as physiological diseases on page 445 are not well understood; some of them, like cancer, may yet prove to be germ diseases; others are due to wrong chemical changes in the body that as yet we cannot remedy; a third great group of the most important of them are connected with the degenerative changes in the tissues described on page 426, and with other kinds of degeneration which we shall not attempt to explain.

These degenerative changes take place most frequently of all in the walls of the arteries and in the tissues of the kidneys and heart. Because of their great importance and because there is hope that in a

measure at least they can be prevented, we shall discuss the causes of these diseases.

**The causes of degeneration of the tissues.** The degenerative changes in the tissues are to be looked on as the wear and tear that takes place in the machine. They are the same changes that are found in old age — in fact, they *are* old age. It is probable that anything that injures the health of the body in any way hastens thesc changes, and hurries us into old age faster than we otherwise should go. The following causes, however, are agreed on by most medical men as being directly responsible for many of these tissue changes:

*Acute infectious diseases.* After severe cases of diphtheria, scarlet fever, measles, pneumonia, grip, meningitis, typhoid fever, and other infections, degenerative changes have been found in the arteries of even young children. With the knowledge that we now have it is possible to prevent practically all of our acute diseases, and every one ought to be protected from them.

*Chronic infectious diseases.* In the diagram on page 445, heart disease, Bright's disease, and diseases of the arteries are shown as physiological diseases. It would perhaps be better to call them germ diseases; for in recent years it has been found that nearly all cases of them are caused by slow-growing varieties of germs. The two great methods of defending ourselves against these diseases are to give attention to the teeth, tonsils, nasal sinuses, or other parts where the germs have made a permanent home, and to live a hygienic life so that the resistance to the germs will be built up.

*Intestinal toxins.* These toxins when injected into the blood of animals cause the degenerative changes in

the tissues which we have described. There is little doubt that when they are absorbed into the blood from the intestines they have the same effects, and that they are one of the greatest of all causes of the diseases that we are discussing.

*Alcohol.* Users of alcohol suffer exceedingly from these changes in the arteries, kidneys, and heart. The effect of the alcohol often shows itself but little until middle life, when the drinker suddenly finds that the organs which must keep up the circulation of his blood and excrete the poisons from his body have already reached old age (see footnote, page 425).

**The possibilities of health and long life.** Ninety-five per cent of all human beings come into the world with sound and healthy bodies. Is it necessary that these bodies shall suffer from disease? There are prophets of health who look forward to the day when men shall pass from birth to old age without sickness or pain. Is it necessary that our cells and tissues shall grow old and wear out? Probably, yes, but with proper care of the body the passage of time works comparatively slight changes in the tissues and with the knowledge that we now have it would be possible to extend the average life far beyond the limit that it has yet reached in the most advanced countries in the world.

Within the lifetime of men and women who are now at middle age, more has been done to free mankind from the bondage of disease than was accomplished in all the previous history of the world. Still greater hygienic discoveries are almost in sight ahead of us, and no one can estimate the health possibilities that lie before the boys and girls of today. Three hundred years ago the

average human machine in Europe lasted twenty years; today it lasts forty years; intelligently cared for according to the knowledge that we now have it would probably last seventy years. To what limit new hygienic discoveries and careful hygienic living will extend the life of this wonderful machine, the future alone can reveal.

### QUESTIONS

Explain what is meant by the limiting factor in crop raising. Discuss the limiting factor in health. Into what two classes may diseases be divided? What is the trouble in each case? Name some of the more important diseases belonging to each class.

What are disease germs? How do they injure the body? What proportion of the deaths in the United States is due to germ diseases? What additional damage is often done by them?

In what two ways are we protected against germs? What are opsonins? How may the amount of an opsonin or of a germicidal substance in the blood be increased? What is done in vaccination?

Is good health sufficient to protect against germ diseases? Give some facts supporting your answer. Why does a strong condition of the body assist in recovery from germ diseases? In what kind of germ diseases is the general health of the body especially important? What is the only method of avoiding germ diseases?

What organs of the body are most often affected by degenerative changes in the tissues? Give four causes of these changes.

### SUGGESTIONS TO THE TEACHER

*How to Live* (Funk & Wagnalls), authorized by the Hygiene Reference Board of the Life Extension Institute, Inc., and prepared by Fisher and Fisk, gives the best available discussion of the topics treated in this chapter.

# CHAPTER TWENTY-FOUR

## FURTHER FACTS CONCERNING HEALTH

Some years ago a man who at times felt dull and unfit for work went to the hospital of a great medical school. He told the physicians there that he had followed all the ordinary rules of hygiene; that he was careful as to his diet, slept regularly, and had been examined by several medical specialists to see if his eyes, tonsils, or teeth needed attention. No change in his manner of living improved his health, and none of the physicians to whom he had gone had been able to find anything the matter with him. The hospital physicians examined him, and they also failed to locate the trouble. They told him that the causes of some cases of ill health were not yet understood and that until the science of medicine made further advances they could do nothing to aid him.

Are there, then, persons who will not have good health even if they follow all the rules of hygiene that we know? Yes, there are such persons; not many of them, but a few. They are persons whose bodies do not work in a normal way, and the ordinary rules of health do not apply to them. Each year, however, the science of medicine is advancing, and each year some of these seemingly causeless cases of ill health are being explained. In this chapter some of the newer facts and ideas relating to health will be discussed.

**The chemical regulation of the body**. Turn back and read again pages 224 and 225. Then as you study this chapter remember that the whole world of a cell is the lymph about it and that it is what is in the blood and lymph that determines whether the cells shall have

health. Recent studies emphasize this idea more and more. Not only is there a regulation of the body by the nervous system, but there is also a chemical regulation of the body by the blood and lymph. Some of the regulating substances, like the vitamins, come from outside the body; others are produced within it. Many of the mysteries of physiology and medicine are being explained by the presence of materials (often in exceedingly small amounts[1]) in the blood and lymph, or by the absence of certain substances that are normally supplied.

## THE DUCTLESS GLANDS

The names of a number of the ductless glands and their location in the body may be learned from Figure 149. Like all glands, these organs take materials which come to them and build them up into new products. But these glands have no ducts as other glands have. The substances that they build simply soak out through the walls of the gland cells into the lymph and are carried all through the body by the blood.

**The thyroid gland.** The thyroid gland lies on the front and sides of the trachea below the larynx. If in infancy its secretion is lacking, growth and development do not take place as they should; the person becomes a

[1] The smallness of the amounts of many important substances in the body is quite astonishing. In all the blood there is only a small teaspoonful of sugar, a tablespoonful of salt, three fifths of a grain of iodin (equal to three fifths the weight of a grain of wheat), and one to three grains of urea. Vitamins and enzymes are present in unbelievably small amounts, and if an ounce of epinephrin were diluted in enough water to fill a procession of city sprinkling carts sixteen miles long, the tests that the physiologist uses would still detect it.

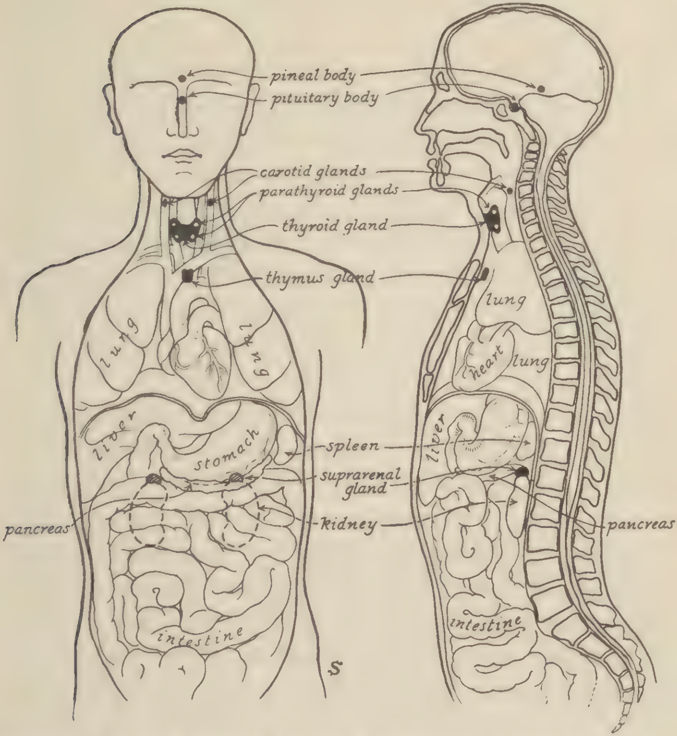



FIG. 149. Diagram showing the location of some of the ductless glands in the body. The thymus in early life is larger than most of the other ductless glands. Little is known of its function or of that of the pineal gland, while the function of the carotid glands is quite unknown. The effects of the secretions of the other glands shown in the drawing are discussed briefly in the text, but the whole subject is so new that our knowledge of it is very incomplete.

dwarf and often an imbecile. If in later life the thyroid fails to secrete sufficiently, the skin becomes thick and dry and the hair tends to become dry and to fall out. Food is not oxidized as rapidly as is normal if the thyroid secretion is insufficient. This causes a tendency to fatness. The person is sensitive to cold, his mind is dull, and it is believed that his resistance to disease germs is low. Physicians treat this disease both in young children and in older persons by feeding extract of the thyroid glands of animals and in this way secure very remarkable results. The first patient so treated kept in good health for twenty-eight years by constantly taking the thyroid material.

On the other hand, the thyroid gland sometimes produces its secretion in too great amount.[1] This causes the ailment known as *Graves' disease*, or *exophthalmic goiter*. Among the symptoms of this disease are a rapid heartbeat, trembling of the hands, a moist skin, and nervousness. In the early stages the patient shows great energy and activity. In later stages there is a sticking out of the eyeballs, and often the gland is enlarged so that it can be plainly seen at the base of the neck. More food than normal is oxidized, and in consequence there is a tendency to thinness and hunger. Physicians treat this ailment by removing a portion of the thyroid gland or by treating the gland with the X-ray.

In some regions enlargement of the thyroid gland

[1] Some physicians believe that sometimes the difficulty in ductless gland troubles is that the glands form the wrong substance, and not merely too much or too little of the normal secretion.

(simple goiter) is very common among both people and animals, and it has now been discovered that in these regions there is a lack of iodin in the soil and consequently in the crops grown on the land and in the water that is used for drinking purposes. If iodin is added to the food, the disease is prevented; so this mineral is supplied to farm animals and even to the young fish in the hatcheries. In some parts of Switzerland where goiter is very common, only salt brought from non-goitrous regions, or that has had iodin added to it, is allowed to be sold. In one city in the United States iodin is being added to the water supply. That the taking of more iodin than is naturally present in the food and water is in some places advisable, is shown by the results secured at Akron, Ohio. Here a large number of school children were given small doses of iodin in the spring and fall for two and one-half years.[1] Of 2190 without signs of goiter taking the iodin, only five developed symptoms, and of 1182 having symptoms, 773 improved. At the same time, other children who did not take iodin were examined. Of these, 495 out of 2350 developed symptoms of goiter in the two and one-half years, and of 1048 having symptoms only 145 improved.

**The parathyroid glands**. The parathyroids, usually four in number, lie on the back and lower part of the thyroid, two on each side. They are flattened, reddish-brown bodies, about the size of small beans. When they are removed from an animal, convulsions and death soon follow. The function of these glands is not definitely

[1] The amount given was two grams of sodium iodid in .2-gram doses administered each school day for two weeks.

FIG. 150. Two side-show companions. The giant owes his unusual height to an overabundant supply of the secretion from the fore lobe of the pituitary gland. The small stature of the dwarf, who is about thirty years of age, is due to an insufficient supply of this same secretion.

known. It has been thought that they are perhaps concerned in the use of calcium in the body, but our knowledge of them is so scant that it is of little or no practical use.

**The pituitary gland.** This small gland lies on the bottom of the brain above the pharynx. It consists of two parts, a front and a back lobe, which are composed of different kinds of cells and which produce entirely different secretions.

The front lobe controls the growth of the bony skeleton. If in childhood the secretion from it is low in amount, the person will not grow and mature in a normal way, and if the secretion is markedly lacking, he will be a dwarf. On the other hand, an overabundance of the se-

cretion during the growing period causes a person to become a giant. An examination of the skull of a giant always shows the bony pocket on the floor of the cranium in which the pituitary body lies to have been unusually large.[1]

The secretion from the back lobe of the pituitary body seems to influence the use of carbohydrates in the body, and probably also to regulate the muscles of the alimentary canal and blood vessels. If it is low in amount, there is a tendency to fatness. There is also a lack of energy and life, while on the other hand an abundant secretion from the back lobe seems to give vigor and endurance both to the muscles and to the mind. In a number of persons who have headache the seat of the trouble seems to be in the pituitary gland.

**The adrenal bodies**. The adrenal glands lie on the kidneys, one on each kidney. They are flattened, oval bodies, perhaps an inch and a half in length. Like the pituitary gland, the adrenals are composed of two distinct kinds of cells which give secretions that have wholly different effects.

The secretion from the outer cells (cortex) seems to be associated with masculine characters. In boys, when the supply is low, the voice changes slowly and the beard is scant. When the supply is overabundant, the voice may change even at nine or ten years of age and the beard start at a very early age. In women a tumor on the suprarenal body, which causes an overgrowth of the outer

[1] By X-ray photographs physicians can determine the size of this pocket and thus learn whether the pituitary gland in a person is large or small.

cells, causes the development of a beard and produces the " bearded lady " of the side show.

The central cells (medulla) of the adrenals produce a substance called *epinephrin* that is now extensively used in medicine. It stimulates the heart more effectively than anything else known, causes a tightening up of the arteries when these are lying flabby and relaxed in cases of weakness or shock, and if painted on a wounded surface will cause the small arteries to contract and check the bleeding, in part at least. It also gives strength to the muscles.

This substance can be detected in the blood if it is present in sufficient amounts, and it is known that in anger or when great effort is made, it is thrown off from the glands. Many investigators believe that a constant supply of it is furnished to the blood, which keeps all the muscles of the body (including the heart and blood vessels) in tone. Others believe in the " emergency theory," that the epinephrin is thrown into the circulation only at times when great strength or endurance is likely to be needed. It has been suggested that the " second wind " which comes to the tiring athlete may be due to a supply of epinephrin reaching the muscles and giving them new power.

**The islands of Langerhans**. These are small groups of cells that lie scattered through the pancreas and are entirely distinct from the cells that secrete the pancreatic juice. The cells of these islands produce a substance called *insulin*, that makes the body able to use sugar. Without it the sugar is not oxidized by the cells and passes off through the kidneys, causing the disease called *dia-*

*betes.* Because the group of cells which produce the secretion is mixed in among the other pancreatic cells, it was impossible until recently to secure from them a supply of the insulin in an effective form. Now this has been done, and with it physicians are able to relieve sufferers from this disease.

**Other facts about the ductless glands.** There are a number of other ductless glands in the body besides those mentioned. Some of these are known to have great effects on the body. Of the function of others, little or practically nothing is known. In general, the secretions of the ductless glands regulate the processes of the body. Fatness or leanness, tallness or shortness, too great energy and excitability or dullness and fatigue, voracious appetite or little desire for food, baldness or an abundance of hair, all these may at times be due to the action of these glands. Many cases of chronic ill health are also due to a lack of a proper balance of their secretions, and an understanding of the importance of these glands has opened a whole new field of hygiene.

The whole subject, however, is very complicated, and only a physician can give safe advice in any particular case. The working of one gland often affects others, so that it is difficult to determine which one was first at fault. Moreover, too much secretion is very commonly followed by a period of too little secretion, making it difficult to decide whether at any given time the gland is underactive or overactive. Giants, for example, who show in their stature the results of too much pituitary secretion, usually suffer in later life from too little of this secretion. One who imagines that he has

symptoms of glandular disturbance should not begin taking gland extracts without medical advice, for these extracts are powerful medicines, and if the wrong ones are taken, much injury may be done.

**Causes of trouble with the ductless glands**. Goiter seems to be often due to a lack of iodin, but our present knowledge indicates that the two most common causes of other diseases of the ductless glands are infections and too strenuous a life. Undoubtedly in diseases like influenza, malaria, typhoid fever, diphtheria, and tuberculosis these glands are often injured, probably in many cases for all time. In the weak period during recovery from these diseases, physicians often prescribe gland extracts to help bring the patient back to health and strength, and preventing germ disease is doubtless a most important step in the avoidance of trouble with the endocrine glands.

The other method of avoiding these troubles is to live a quiet, sensible life and not undertake work or other activity beyond one's strength. Worry, anger, fear, great effort or strain of any kind, causes an unusual amount of secretion to be produced by some of the glands at least, and many persons are so constituted that if the exciting conditions are kept up the glands in time become exhausted and fail in their work. Unfortunately, a wrought-up nervous system speeds up the glands and the glands in turn speed up the nervous system, so that a person under strain, instead of stopping for rest, has a tendency to keep increasing his pace. *The great majority of persons must have rest and recreation to keep their ductless glands working in a normal way.*

## SENSITIZATION TO PROTEINS

If a little sterile milk or white of egg is injected into the abdominal cavity of a guinea pig, no harm is done the animal. But if a second dose is given it two weeks later, it will in a few minutes begin scratching at its mouth and have difficulty in breathing, and may even die. It suffers from an attack of asthma in which the muscles of the small air tubes contract and shut off the air from the sacs of the lungs. After the first dose the animal becomes "sensitized" to the protein used. Just why this is true can be explained only in part, but if a "foreign" protein (one not digested and prepared for absorption into the body) gets into the blood, the cells become sensitized to it.

It has been discovered that a considerable number of persons are sensitive to proteins that they breathe in or take in their food. How they become sensitive to these proteins is in many cases difficult to explain, but they are sensitive, and when the proteins get into the system a variety of effects is produced. Some of the more practical phases of this question will be discussed.

**The skin test for protein sensitivity**. Whether a person is sensitive to any given protein can be determined by a simple skin test. A very slight scratch (not deep enough to draw blood) is made on the arm, and a little of the protein is rubbed into the wound. If the person is not sensitive, no reaction follows. But if he is sensitive, the skin rises in a thick welt (like a "hive") about the wound. By a couple of rows of scratches down one

*X, Typical reaction* *Y, Negative control*

FIG. 151. The result of a skin test with horse-hair protein on an asthma patient. At the place marked *X* a scratch on the skin was made and the protein rubbed in; at the place marked *Y* the skin was also slightly scratched, as for the other test, but no protein was rubbed in.

arm the test for a large number of proteins can be made at once, and the offending ones can usually be thus picked out.

After one has learned that he is sensitive to a protein, he can then often keep from inhaling it or taking it in his diet. If this is not possible, the person can be "desensitized" by a course of vaccination with the protein. It must be noted, however, that the skin test probably fails in some cases of protein sensitization and that our knowledge is not yet sufficient to allow it to be said with certainty that vaccination against the sensitivity will always succeed. And it should perhaps be noted further that, in some cases at least, the vaccination must be repeated at intervals to keep the immunity from being lost.

**Hay fever**. A considerable number of persons are sensitized to wind-borne pollens — the pollens of grasses, weeds, and other plants. When these pollens are in the

air, such persons become afflicted with hay fever, which resembles a violent cold in the head. As a preventive and remedy, the patient can be desensitized by vaccination with the protein of the pollen that causes the trouble. In hay fever there is often an abundant growth of bacteria in the affected parts, and it may be necessary to vaccinate against these as well as with the pollen.

**Asthma**. A large percentage of all persons suffering from asthma are sensitive to some protein, and when they keep away from this they are not troubled with the disease. Sometimes the protein is taken in the food; quite often it is inhaled. In many cases the trouble is due to dust from horses, the hair from dogs or cats, feathers from a pillow, rabbit fur from a couch or mattress, or even orris root from face powder.

The first step for an asthma patient is to be tested to find the protein to which he is sensitive, unless he already knows this. Then, if he cannot keep away from this protein, a course of vaccination is in order.

Like other persons who suffer from chronic ailments, asthmatic patients frequently become exceedingly anxious to be restored and are willing to try anything that promises relief. On this account, numerous patent medicines for asthma are on the market. Many of them contain opium, and of course they can in no way remove the cause of the disease.

**Skin troubles from protein sensitivity**. An occasional person, after eating some article of food (e.g., fish, eggs, strawberries), will break out with hives. In other persons the offending food causes a swelling of the lips and tongue or a more or less constant blotchy and itchy

condition of the skin. Any one with skin trouble can well afford to consider whether the cause is not sensitivity to some food.

**Other troubles due to sensitivity to proteins**. This subject is very new, and our knowledge of it is incomplete. We know enough, however, to appreciate the truth of the old proverb that "what is one man's meat is another man's poison." There are babies to whom cows' milk is poison. There are persons who are made uncomfortable or ill by eating some of our most highly esteemed foods. There is evidence that some cases of headache and chronic ill health may be due to sensitization to proteins that, like those of bread or beef, are taken every day in the food. Just what will develop in this field the future must tell, but the principles involved are of wide application. Consumptives react to the tuberculin test because they are sensitive to the protein of the tubercle bacillus. Other similar tests are used in medicine, and desensitization to a protein and vaccination are near akin.

It should be noted that a person who has just come through an attack of asthma or hives may for a time be immune to the protein that caused it and does not react to the skin test, the eating or breathing in of the protein seeming to act as a vaccination. The type of headache that some physicians believe to be due to protein sensitivity is the one that comes at intervals and leaves the patient in good health for a few days after the attack has gone. Some physicians believe that certain cases of epilepsy are also due to sensitization to food.

## THE EFFECT OF DRUGS ON THE BODY

In this connection it is of interest to note that many mineral and vegetable substances, even in small amounts, also have great effects on the body. Arsenic and mercury are strong mineral poisons. Strychnia and bella donna are examples of poisons from plants. Alcohol, wood alcohol, and caffein are other examples of substances of vegetable origin that have a marked effect on the body.

Some drugs are peculiar in that after they have been taken a few times there is a tendency to form the habit of taking them. Alcohol, tobacco, coffee, and tea are the substances most commonly taken habitually, and doubtless the world would be better if all these substances could be banished from it. Opium, heroin, cocain, and morphine are other habit-forming drugs that exert a profound influence on the cells.

The use of these last-named and other similar drugs has become a real evil in our country, and it is well that every one should understand the dangers connected with them. Sometimes persons begin taking them because they are in pain or cannot sleep. Sometimes they have much work to do and great responsibilities to carry, and they take the drug to brace them up for a time. Generally the drug is taken thoughtlessly in the beginning, because it is furnished by some one who hopes to fix the habit on the user and later profit by the sale of the drug to him.

The one safe rule to follow in connection with these drugs is to let them alone. The secretions of the ductless glands normally belong in the body and are needed

to keep the natural processes going on in the cells. Drugs, on the other hand, are foreign substances that throw the body processes out of their natural courses and so interfere with or destroy the health. For this reason drugs or medicines of any kind should be taken only on the advice of a physician, and a physician should be careful as to the advice that he gives.

### QUESTIONS

Give some examples of substances that regulate the body. Name some of the ductless glands. What do these organs do? Why are they called "ductless" glands?

Where is the thyroid gland situated? What is the effect on a young child of not enough thyroid secretion? on an older person? How do physicians treat these cases?

What are the effects of too much thyroid secretion? What disease is common where there is a lack of iodin in the soil and water? How can this disease be prevented?

Where are the parathyroid glands located? the pituitary gland? What effect has the secretion of the front lobe of the pituitary gland? of the back lobe? Where are the adrenal bodies? What are the results of too much and too little secretion from the outer cells of these bodies? What substance is produced by the central cells? How is this used in medicine? What is supposed to be its function in the body?

What substance is produced by the groups of cells in the pancreas? What effect has this substance on the body? Why is the study of the ductless glands difficult? Why should extracts from these glands be taken only on the advice of a physician? Give two causes of trouble with the ductless glands.

How is a person tested for sensitivity to protein? How is desensitization carried out? What is the cause of hay fever? of asthma? What treatment is given for these diseases? What skin troubles may be due to food sensitivity? What other troubles may be due to this cause?

Name some mineral or vegetable substances that have marked effects on the body processes. Name some habit-forming drugs. How is the drug habit usually started? What rule should be followed in connection with these drugs?

# CHAPTER TWENTY-FIVE

## VITAMINS

EACH year our knowedge of vitamins is extended, and each year their importance is more and more appreciated. They have been mentioned in connection with foods (page 355), but because a sufficient supply of them is so absolutely necessary for health, they will be discussed in somewhat more detail at this point. Four of them — called, respectively, vitamin A, B, C, and D — are now known.

An interesting fact is that chemical tests indicate that perhaps vitamin C is quite closely related to epinephrin, and it has been suggested that possibly this vitamin is necessary to the body in order that the adrenal glands may have the raw material for the manufacture of their product. An understanding of vitamins from a chemical

*National Dairy Council*

FIG. 152. Photograph showing the effect of vitamin A on growth. The rats are sisters of the same age. Both had the same diet except that the one on the right had butter, which furnished it with vitamin A, while the one on the left was supplied with other fats which lacked this vitamin.

National Dairy Council

FIG. 153. These chickens are sisters of the same age and the same hatch. After hatching, both were fed all the wheat, oats, corn, and millet they would eat. The larger was fed milk every day in addition, while the smaller one received no milk. The milk supplied amino-acids, vitamins, and minerals not furnished in sufficient amounts by the other food.

standpoint and a knowledge of what they do in the body would doubtless be of immense value in hygiene. At present our knowledge of them must be gained by feeding experiments on animals and by observations of the effects of different diets on men.

**Vitamin A**. Vitamin A is manufactured in the leaves (green parts) of plants. It is found stored in other parts of some plants (see pages 355 and 386). The cow takes it from the food that she eats and secretes it in the milk, and the hen likewise extracts it from her food and gives it to us in the yolks of eggs. The amounts in eggs and milk vary, however, with the diet of the hen and cow. When a cow is on grass, the milk is much richer in this vitamin than when she is kept on dry feed. The vitamin content

*Connecticut Agricultural Experiment Station*

FIG. 154. This miserable-looking rat had before him at all times food that would supply everything needed except vitamin B. Each day he ate less and less and at the end of a month was about to die. Then he was supplied with the lacking vitamin, with the results shown on the next page.

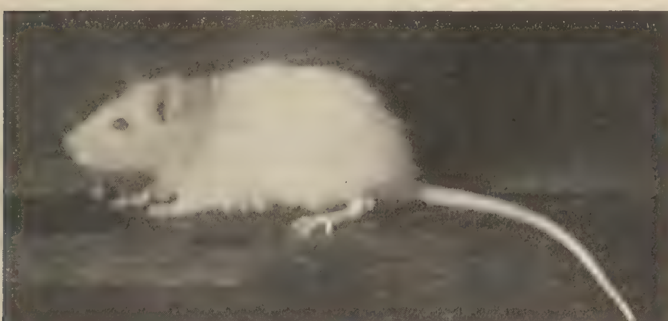
of the milk of a nursing mother also varies with the diet taken. In order that the baby may be sure of having enough of vitamin A, the mother should eat green vegetables and use freely butter and milk.

When animals are given a diet lacking vitamin A, growth stops entirely and soreness of the eyes develops. When the supply of the vitamin is low, growth is slow and the health poor. In parts of South America where the people live to a very large extent on meat, eye disease due to a lack of this vitamin is quite common.

**Vitamin B**. Vitamin B is found in whole grains; in beans, peas, potatoes, turnips, and other vegetables; in milk and eggs; and in various other foods. In our country almost every one secures enough of this vitamin, but the lack of it causes a disease of the nervous system called *beriberi*, which is responsible for many deaths in some countries.

In grains, vitamin B is in the surface layers, and among peoples like the Filipinos and Japanese, who live largely on polished rice, many persons lack a sufficient supply of it. Sailors and some of the inhabitants of Labrador have also suffered from beriberi because of living on a diet composed almost entirely of white bread and salt meat.

**Vitamin C**. Vitamin C is abundant in oranges, lemons, tomatoes, and rutabagas, and in general in fresh vegetables and fruits. The lack of it causes a disease called *scurvy*, in which the joints are swollen and tender and there is bleeding of the gums and loosening of the teeth. This disease can be prevented by the use of fresh fruits and vegetables, and in babies is relieved in a wonderful way by giving the juice of oranges, tomatoes, or rutabagas. Milk is only moderately rich in vitamin C, and a baby should have an additional supply of the vitamin in orange juice or in some other food. This vitamin is



*Connecticut Agricultural Experiment Station*

FIG. 155. Within a few hours after receiving the vitamin the rat was again eating and in 24 hours was running about. A few days later he was in good flesh and afterward grew at the normal rate.

destroyed by heating unless acid is present, and babies fed on pasteurized, canned, or dried milk are especially likely to lack it. In former times, when ocean voyages often lasted for months, sailors suffered greatly from a lack of vitamin C.

**Vitamin D**. Vitamin D has only recently been discovered. The lack of it, in connection with a low supply of either calcium or phosphorus, or a bad balance between the supply of these minerals, causes rickets — a disease in which the bones and teeth are soft because lime is not deposited in them. It is not known what foods supply us with vitamin D. Cod-liver oil will cure rickets, and so it must contain the vitamin. It is present in egg yolk also, and is probably found in tomatoes and green leaves.

Recent experiments indicate that certain persons have soft, defective teeth which decay easily because they lack either a sufficient supply of vitamin D or of the minerals needed for building sound, hard teeth. It is known that tooth decay is practically unknown among certain primitive peoples, and it appears that the problem of keeping the teeth sound cannot be solved without attention to the diet. From our present knowledge it seems probable that many persons could greatly improve the quality of their teeth by eating more green vegetables.

**QUESTIONS**

How many vitamins are now known? Where is vitamin A manufactured? Name some foods in which it is found. What effect has a lack of this vitamin?

Name some foods rich in vitamin B. What disease is due to a lack of this vitamin? Where is vitamin C found? What ailment results from a lack of it? How can it be supplied to babies?

What disease is due to a lack of vitamin D? In what foods is this found? What is the probable cause of soft teeth?

# APPENDIX

## A. SOME IMPORTANT FACTS IN REGARD TO CERTAIN INFECTIOUS DISEASES

| Disease | Infectious Material | Incubation Period | Early Symptoms | Time Usually Excluded from School |
|---|---|---|---|---|
| Scarlet fever | Discharges from mouth and nose | Two to five days | Vomiting, sore throat, headache, or fever. Rash usually appears within 24 hours on neck and chest | About six weeks from beginning of disease |
| Diphtheria | Discharges from mouth and nose | Few hours to seven days | Sore throat with white patches, swelling of the glands of the neck. In nasal diphtheria, lips are often sore from discharges from nose | Until two negative cultures are obtained |
| Measles | Discharges from mouth and nose | Ten to fourteen days | Cold in head; inflamed eyes, sneezing and coughing. Rash first appearing on forehead and face about third or fourth day | About three weeks |
| Chicken pox | Fresh or dried matter from eruption | Fourteen days (eleven to nineteen) | Fever sometimes mild. Rash on second day, developing later into crusts | Until scales and crusts have disappeared |
| Whooping cough | Discharges from mouth and nose | Fourteen days (may be shorter) | Cold in the head, and cough | Five weeks from beginning of disease, or until the "whoop" has entirely disappeared |
| Mumps | Discharges from mouth and nose | Fourteen to twenty-one days | Slight fever, pain and swelling of the jaw | Four weeks from enlargement |

In some cases discharge from the eyes and ears may also be infectious. Incubation periods are often irregular and may be longer or shorter than the periods given.

## B. VITAMINS IN DIFFERENT FOODS

| Name of Food | Vitamin A | Vitamin B | Vitamin C | Vitamin D |
|---|---|---|---|---|
| Foods of Animal Origin: | | | | |
| Beef fat | + | − | − | ? |
| Butter | +++ | − | − | ? |
| Brains | + | ++ | + | ? |
| Cheese | ++ | ? | ? | ? |
| Cod-liver oil | +++ | ? | − | ++ |
| Eggs | ++ | + | + | + |
| Fish fat | + | + | ? | ? |
| Fish roe | + | ++ | + | ? |
| Honey | − | + | − | ? |
| Lard | + | − | − | ? |
| Liver | ++ | ++ | + | ? |
| Meat, lean | − to + | + | + | ? |
| Milk, raw | +++ | ++ | (variable) | + |
| evaporated | +++ | ++ | (variable) | ? |
| condensed | +++ | ++ | (variable) | ? |
| Foods of Plant Origin: | | | | |
| Apples | + | + | + | ? |
| Bananas | + | + | + | ? |
| Beans, navy | ? | +++ | − | ? |
| string, fresh | ++ | ++ | ++ | ? |
| Beets | ? | + | ? | ? |
| Cabbage (cooked) | + | ++ | ++ | ? |
| Carrots (cooked) | ++ | + | + | ? |
| Cauliflower | + | ++ | + | ? |
| Coconut | + | ++ | ? | ? |
| Coconut oil | − | − | − | ? |
| Corn, white | − | ++ | − | ? |
| Corn, yellow | + | ++ | − | ? |
| Cottonseed oil | + | − | − | ? |
| Eggplant (dried) | ? | ++ | ? | ? |
| Grape juice | ? | + | + | ? |

## B. VITAMINS IN DIFFERENT FOODS *(Continued)*

| Name of Food | Vitamin A | Vitamin B | Vitamin C | Vitamin D |
|---|---|---|---|---|
| Grapefruit | ? | ++ | ++ | ? |
| Lemon juice | ? | ++ | +++ | ? |
| Lettuce | ++ | ++ | +++ | ? |
| Orange juice | + | ++ | +++ | ? |
| Prunes | ? | + | – | ? |
| Oats | + | ++ | – | ? |
| Rice, polished | – | – | – | ? |
| Rutabaga | ? | ++ | +++ | ? |
| Potato, sweet | ++ | + | ? | ? |
| white (boiled 15 min.) | ? | ++ | ++ | ? |
| white (baked) | ? | ++ | + | ? |
| Peas | ++ | ++ | + | ? |
| Parsnips | ? | ++ | ? | ? |
| Peanuts | + | ++ | ? | ? |
| Squash, Hubbard | ++ | ? | ? | ? |
| Sugar | – | – | – | ? |
| Tomatoes (raw or canned) | ++ | +++ | +++ | ++ |
| Spinach (fresh) | +++ | +++ | ? | ? |
| Turnips | ? | ++ | ? | ? |
| Wheat (whole) | + | ++ | – | ? |
| Bread, white (milk) | + | + | ? | ? |
| whole wheat (milk) | ++ | + | ? | ? |

+ indicates that food contains the vitamin.
++ indicates that food is a good source of the vitamin.
+++ indicates that food is an excellent source of the vitamin.
– indicates that the food contains no appreciable amount of the vitamin.
? indicates that it is not known whether vitamin is present.

## C. FOOD VALUES AND COSTS

| Name of Food | Refuse | Edible Portion | | | | | | | | Money Value of Food as Purchased Compared with an Equal Weight of White Bread |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Water | Protein | Fat | Carbo-hydrate | Calcium (CaO) | Potassium ($K_2O$) | Phosphorus ($P_2O_5$) | Iron | |
| | % | % | % | % | % | % | % | % | % | |
| Apples | 25 | 84.6 | 0.4 | 0.5 | 14.2 | .014 | .15 | .03 | .0003 | .07 |
| Bacon | — | 18.8 | 9.9 | 67.4 | — | | | | | 1.95 |
| Beans (string) | 7 | 89.2 | 2.3 | 0.3 | 7.4 | .075 | .28 | .12 | .0016 | .20 |
| Beans (lima, dried) | — | 10.4 | 18.1 | 1.5 | 65.9 | .10 | 2.10 | .77 | .0070 | 1.78 |
| Beef (round, lean) | 8.1 | 70 | 21.3 | 7.9 | — | .011 | .42 | .50 | .0038 | 1.72 |
| Beets (fresh) | 20 | 87.5 | 1.6 | 0.1 | 9.7 | .03 | .45 | .09 | .0006 | .22 |
| Bread (white) | — | 35.6 | 9.3 | 1.2 | 52.7 | .03 | .10 | .20 | .0009 | 1.00 |
| Bread (whole wheat) | — | 38.4 | 9.7 | 0.9 | 49.7 | .04 | .27 | .40 | .0015 | 1.02 |
| Butter | — | 11 | 1 | 85 | — | .02 | .02 | .03 | — | 1.48 |
| Buttermilk | — | 91 | 3 | 0.5 | 4.8 | .15 | .18 | .22 | — | .27 |
| Celery | 20 | 94.5 | 1.1 | 0.1 | 3.3 | .10 | .37 | .10 | .0005 | .08 |
| Cheese (cream) | — | 34.2 | 25.9 | 33.7 | 2.4 | | | | | 2.69 |
| Chestnuts (fresh) | 16 | 37.8 | 5.2 | 4.5 | 35.4 | .04 | .50 | .20 | .0010 | .64 |
| Chocolate | — | 5.9 | 12.9 | 48.7 | 30.3 | .14 | | .90 | | 1.98 |
| Clams (without shell) | — | 80.8 | 10.6 | 1.1 | 5.2 | | | .40 | | .91 |
| Corn (green) | 61 | 75.4 | 3.1 | 1.1 | 19.0 | .008 | .131 | .22 | .0008 | .13 |
| Cornmeal (granular) | — | 12.5 | 9.2 | 1.9 | 75.4 | .015 | .17 | .30 | .0011 | 1.10 |
| Dates (dried) | 10 | 15.4 | 2.1 | 2.8 | 78.4 | .10 | | .12 | .0030 | .54 |
| Eggs (uncooked) | 11.2 | 73.7 | 13.4 | 10.5 | — | .093 | .165 | .37 | .0030 | 1.23 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Figs (dried) | — | 18.8 | 4.3 | 0.3 | 74.2 | .299 | 1.478 | .332 | .0032 | 1.02 |
| Fish (cod, dressed) | 29.9 | 82.6 | 16.5 | 0.4 | — | .015 | .40 | .40 | .0004 | .91 |
| Fowl (chicken, plucked) | 25.9 | 63.7 | 19.3 | 16.3 | — | .015 | .56 | .58 | | 1.33 |
| Grapes | 25 | 77.4 | 1.3 | 1.6 | 19.2 | .024 | .25 | .12 | .0013 | .16 |
| Ham (smoked, medium fat) | 13.6 | 40.3 | 16.3 | 38.8 | — | | | | | 1.71 |
| Honey | — | 18.2 | 0.4 | — | 81.2 | .005 | .50 | .04 | .0010 | .36 |
| Lamb chops | 13.5 | 47.6 | 21.7 | 29.9 | — | | | | | 1.95 |
| Lettuce | 15 | 94.7 | 1.2 | .3 | 2.9 | .05 | .42 | .09 | .0010 | .10 |
| Milk | — | 87 | 3.3 | 4 | 5.0 | .168 | .171 | .215 | .0002 | .35 |
| Mushrooms | — | 88.1 | 3.5 | 0.4 | 6.8 | .024 | .46 | .24 | | .32 |
| Muskmelon | 50 | 89.5 | 0.6 | — | 9.3 | .024 | .283 | .035 | .0003 | .04 |
| Oatmeal | — | 7.3 | 16.1 | 7.2 | 67 5 | .13 | .458 | .872 | .0036 | 1.72 |
| Onions (fresh) | 10 | 87.6 | 1.6 | 0.3 | 9.9 | .06 | .23 | .12 | .0005 | .15 |
| Oranges | 27 | 86.9 | 0.8 | 0.2 | 11.6 | .06 | .22 | .05 | .0003 | .01 |
| Peanuts | 24.5 | 9.2 | 25.8 | 38.6 | 24.4 | .10 | .85 | .90 | .0020 | 2.16 |
| Peas (dried) | — | 9.5 | 24.6 | 1.0 | 62.0 | .14 | 1.06 | .91 | .0056 | 2.30 |
| Pork (loin chops, lean) | 23.5 | 60.3 | 20.3 | 19 | — | .012 | .34 | .45 | | 1.51 |
| Potatoes (white) | 20 | 78.3 | 2.2 | 0.1 | 18.4 | .016 | .53 | .14 | .0013 | .21 |
| Potatoes (sweet) | 20 | 69 | 1.8 | 0.7 | 27.4 | .025 | .47 | .09 | .0005 | .27 |
| Prunes (dried) | 15 | 22.3 | 2.1 | — | 73.3 | .06 | 1.20 | .25 | .0029 | .40 |
| Raisins | 10 | 14.6 | 2.6 | 3.3 | 76.1 | .08 | 1.00 | .29 | .0050 | .52 |
| Rice | — | 12.3 | 8.0 | 0.3 | 79.0 | .012 | .084 | .203 | .0009 | .98 |
| Spinach | — | 92.3 | 2.1 | 0.3 | 3.2 | .09 | .94 | .13 | 0032 | .19 |
| Squash | 50 | 88.3 | 1.4 | 0.5 | 9.0 | .02 | .05 | .08 | .0008 | .08 |
| Tomatoes | — | 94.3 | 0.9 | 0.4 | 3.9 | .20 | .35 | .059 | .0004 | .09 |
| Walnuts (soft shelled) | 58.1 | 2.5 | 16.6 | 63.4 | 16.1 | .108 | .44 | .77 | .0021 | 1.03 |

NOTE. The values appearing in the last column of the table on the preceding pages have been secured by the use of the formula given in Murray's *Economy of Nutrition* (Appleton). This author finds that on an average a pound of protein costs about 20 times as much as a pound of carbohydrate, and a pound of fat about four times as much. The value of a food may therefore be said to be equal to the protein $\times$ 20 + fat $\times$ 4 + carbohydrates. The method of making the computations will be understood from the following sample problem, in which the relative values of pecans and of an equal weight of dried figs are calculated. Pecans (as purchased) contain 5.1 per cent protein, 37.9 per cent fat, and 8.2 per cent carbohydrates. Dried figs contain 4.3 per cent protein, .3 per cent fat. and 74.2 per cent carbohydrates. The relative values of these two foods may therefore be expressed by the equation

$$\frac{5.1 \times 20 + 37.9 \times 4 + 8.2}{4.3 \times 20 + .3 \times 4 + 74.2} = \frac{261.8}{161.4} = 1.62.$$

That is, a pound of pecans ought, theoretically, to sell in the market for 1.62 times as much as a pound of figs. In the table on page 482 the value of bread is taken as 1, and the other foods are compared with it. The values of any two foods can be compared in this way, and it can then be determined which is the cheaper at current market prices. The teacher will understand, however, that in determining the real value of an article of food there may be many factors not taken into account in the above formula.

Bulletin No. 28 of the United States Department of Agriculture contains a very complete list of analyses showing the chemical composition of American foodstuffs. It is sold by the Superintendent of Public Documents, Washington, D.C., for ten cents.

# PRONOUNCING GLOSSARY

This glossary is intended chiefly to help the pupil in the pronunciation of the more difficult terms. A few words are defined; the meaning of those not defined is made clear in the places where they occur in the text.

**abdomen** (ab-dō′men).
**abdominal** (ab-dŏm′i-nal).
**adenoid** (ăd′en-oid).
**Agave** (a-gah′vĕ).
**ameba** (a-mē′ba), *a rather large protozoön that has no cell wall about it, changes its shape, and takes in its food in the same way as a white blood corpuscle engulfs bacteria* (Fig. 9).
**amylopsin** (ă-mĭ-lŏp′sin).
**anemia** (a-nē′mi-a).
**Anopheles** (A-nŏf′ĕ-lēz).
**appendicitis** (ap-pen-dĭ-sī′tis).
**aqueous** (ā′quē-ŭs).
**astigmatism** (as-tĭg′mat-ism).
**auricle** (o′ri-cl).
**bacillus** (ba-sĭl′lŭs).
**bacterium** (băk-tē′ri-ŭm).
**beriberi** (bĕr′i-ber′i).
**bronchial** (brŏng′ki-al).
**bronchitis** (brŏng-kī′tis).
**canine** (ka-nīn′).
**capillary** (căp′il-lā-re).
**cerebellum** (sĕr-e-bel′lum).
**cerebro-spinal** (sĕr′e-brō-spī′nal).
**cerebrum** (sĕr′e-brum).
**chloral** (klō′ral).
**choroid** (kō′roid).
**cocain** (kō′ka-ĭn).
**coccus** (kŏk′kŭs).
**coccyx** (kŏk′six).
**cochlea** (kŏk′le-a).
**communicable** (com-mu′ni-ca-ble) disease, *a disease that one person can contract from another.*
**cornea** (cor′ne-a).
**corpuscle** (kor′pŭsl).
**Culex** (kū′lex).
**dengue** (dĕn′gā).
**dentine** (dĕn′tĭn).
**diaphragm** (dī′a-frăm).
**diphtheria** (dĭf-thē′ri-a).
**disinfectant** (dis-in-fĕct′ant).
**dysentery** (dĭs′en-tĕr-y̆), *an intestinal disease in which there is a bloody discharge from the bowels.*
**emetin** (ĕm′e-tĭn).
**enzyme** (en′zīm).
**epidemic** (ĕp-ĭ-dĕm′ik) disease, *a disease that people catch from one another easily and which many people have at once. An outbreak of a communicable disease.*
**esophagus** (e-sof′a-gus).
**Eustachian** (yu-stāk′ke-an).
**femur** (fē′mur).
**fertilization** (fer-til-īz-ā′shun).
**gangrene** (găng′grēn), *inflammation that goes on until part of the tissue is dead.*
**germ** (jerm), *a bacterium or a protozoön that can cause disease.*
**germicidal** (jer-mĭ-sī′dal), *germ-killing.*
**glycogen** (glī′kō-jen).
**hasheesh** (hash-ēsh′).
**hemoglobin** (hĕm-ō-glō′bĭn).
**humerus** (hyu′me-rus).
**humidifier** (hyu-mĭd′i-fī-er).
**hygiene** (hī′ji-ēn or hī′jēn).
**hygienic** (hī-je-ĕn′ik).

**incisor** (in-sī′sor).
**infected** (in-fĕkt′ed), *containing germs, as an infected wound.*
**infectious** (in-fĕk′shŭs) disease, *a disease, the germs of which can be passed from one person to another.*
**larynx** (lăr′ĭnks).
**lipase** (lĭp′ās).
**lymphatic** (lim-făt′ik).
**lysol** (lī′sōl).
**magnesium** (mag-ne′zhe-um).
**medulla oblongata** (med-ŭl′la ŏb-lon-gah′ta).
**meningitis** (mĕn-ĭn-jī′tis).
**miasma** (mī-ăz′ma).
**microbe** (mī′krōb), *a living thing so small that it can be seen only through a microscope.*
**molar** (mō′lar).
**narcotic** (nar-kŏt′ic).
**nicotin** (nĭk′o-tĭn).
**nocardia** (nō-card′ē-a).
**opsonin** (ŏp′sō-nĭn).
**pancreas** (păn′kre-as).
**papilla** (pap-il′ah).
**patella** (pa-tĕl′la).
**pellagra** (pĕl-ăg′ra or pĕ-lah′gra).
**pepsin** (pĕp′sin).
**permanganate** (per-măn′gan-āt).
**phalanges** (fȧ-lăn′jēz).
**pharynx** (făr′ĭnks).
**phosphorescent** (fŏs-fo-rĕs′ent).
**poliomyelitis** (pŏl-ĭ-ō-mī-ĕ-lī′tĭs).
**pollen** (pŏl′len).
**polyp** (pŏl′ip).
**proboscis** (pro-bŏs′is).
**protein** (prō′te-in).
**protoplasm** (prō′to-plasm).
**protozoön** (prō-tō-zō′ŏn).
**ptomaine** (tō′ma-ĭn).
**ptyalin** (tī′a-lin).
**pupa** (pū′pa).
**pus** (pŭs).
**pyorrhea** (pī-ŏ-rē′a).
**rabies** (rā′bĭ-ēz).
**respiratory** (rĕs′pĭ-rā-tō-re).
**retina** (rĕt′i-na).
**saliva** (sal-ī′vah).
**salivary** (săl′i-vā-re).
**sanatorium** (săn-a-tō′ri-um), *a place where people go to regain health; a hospital for the treatment of patients who can be cured.*
**sciatic** (sī-ăt′ik).
**sclerotic** (skle-rŏt′ik).
**sepal** (sĕp′l).
**serum** (sē′rum).
**spirillum** (spī-rĭl′lum).
**sputum** (spū′tum), *matter coughed up from the lungs and air passages.*
**stamen** (stā′men).
**stegomyia** (stĕg-ō-mī′ya).
**stomoxys** (stō-mŏk′sĭs).
**strychnin** (strĭk′nĭn).
**tetanus** (tĕt′a-nŭs).
**tonsillitis** (tŏn-sĭl-lī′tis), *inflammation of the tonsils.*
**trachea** (trā′ke-a).
**trachoma** (trā-kō′ma).
**trypsin** (trĭp′sin).
**tuberculosis** (tū-ber-kū-lō′sis).
**tuberculous** (tū-ber′kū-lus), *infected with the germs of tuberculosis.*
**tympanic** (tĭm-păn′ik).
**tympanum** (tĭm′pan-um).
**uretur** (yu-rē′ter).
**virulent** (vĭr′u-lent), *powerful in producing disease.*
**virus** (vī′rŭs).
**vitreous** (vĭt′re-us).

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